THE ENGINEER

A Seven-Day Journal

The Iron and Steel Industry

IN a speech at the annual conference of the Amalgamated Union of Foundry Workers on Thursday of last week, the Minister of Supply, Mr. G. R. Strauss, criticised the British Iron and Steel Federation, suggesting that there was a lack of co-operation between it and the Iron and Steel Corporation of Great Britain. He said that on the part of the Federation there had been a "serious and deplorable" response to the Corporation's desire to exercise effective control over the machinery responsible for the purchase and distribution of iron ore and scrap, and stated also that when the steel companies were transferred to public ownership four months ago, a great shortage of raw materials was discovered. In view of the Minister's comments, the British Iron and Steel Federation has issued a statement and also copies of letters, which have recently passed between its president, Sir Ellis Hunter, and the chairman of the Iron and Steel Corporation, Mr. S. J. L. Hardie. The statement emphasised that, when the Corporation acquired public ownership of certain steel companies on February 15, 1951, stocks of both pig iron and scrap were higher than on the corresponding dates of 1948 or 1949. It was fortunate, the Federation's statement pointed out, that those stocks were at an exceptionally high level in the middle of 1950, when, with the onset of the Korean war and, later, the diversion of shipping to the import of coal, acute difficulties developed in the supply of raw materials. To help meet those difficulties, advantage was taken of the exceptionally high stocks. Although for many years, the Federation observed, the Minister of Supply had been officially notified each week of the stocks of pig iron, scrap and other materials, at no time had he ever suggested that the industry was acting wrongly, either in building up stocks when the opportunity arose, or in making use of the stocks when there were difficulties in the supply of raw materials. The published correspondence contained the Corporation's proposals that it should acquire control of those sections of the Federation's organisation concerned with supplies of raw materials. Replying to the proposals, the President of the Federation recalled that Government spokesmen had emphasised the need to avoid drastic and sudden action in the early days of steel nationalisation. The Federation's opinion was that until the early problems were resolved there should be no question of imperilling by piecemeal approach the efficiency of the steel industry, on which so much depended at present. The president's letter made it plain, however, that the obligation to abide by the Corporation's decision on matters for which it had public responsibility had never been disputed by the Federation.

The Capital Investment Programme

THE Chancellor of the Exchequer, Mr. Hugh Gaitskell, made a statement in Parliament on Thursday of last week about capital investment in the current financial year. He said that the heavy demands of the defence programme on the engineering industries must involve some check to civil investment at home. The total output of those industries was limited by shortages of steel and other materials and the country could not afford a serious decline in exports of metal goods when the rising costs of imports presented a serious threat to the stability of the overseas balance of payments. In consequence, the Chancellor stated, there would be no increase this year in the supplies of plant and machinery available for home industry, while in 1952 and 1953 there must be a substantial reduction since more and more of the engineering industry would be producing armaments. Moreover, of the plant and machinery available for the home market, a much larger share must go from now on to firms engaged in defence production. In the case of the building and constructional engineering industries, Mr. Gaitskell said that output should continue to rise by about 5 per cent a year, although, out of that increase provision would have to be made for a substantial amount of defence work. The Chancellor added that, in view of the uncertainty caused by defence production and material shortages, it was not proposed to publish for 1951 or 1952 a detailed investment programme. Total fixed investment in 1951, however, including defence investment, might amount to £2,230,000,000 (in terms of prices ruling at the end of 1950), compared with £2,162,000,000 in 1950. Within that total it was intended that investment in coal, electricity, gas, coke ovens, railways, roads and petroleum would be higher than in 1950. The programme of new industrial building for manufacturing industry would continue at about the same rate as in 1950, but a proportion of the work would be on projects directly or indirectly related to defence and fewer licences would therefore be available for ordinary civil projects.

Britain's Inland Water Resources

THE first report of the Inland Water Survey Committee to be published since the war was issued by the Ministry of Local Government and Planning and the Scottish Office, on June 25th. The committee recommends that surface water surveys should cover in some degree every part of the basins of all rivers with substantial water resources. Every river board in England and Wales, it is stated, should aim to establish a systematic and permanent network of gauging stations covering its area, and as a result, accurate and comprehensive measurements could be made either continuously or periodically. The committee also recommended that in Scotland an organisation should be set up specifically charged with the duty of survey and equipped with the means to perform it. The results obtained by such measures should, in the committee's opinion, be published so that information would be readily available for judging any fresh scheme put forward for the utilisation of water resources. A further recommendation is that the existing facilities for calibrating current-meters should be greatly improved and expanded. In describing the present arrangements for inland water survey the committee points out that the Meteorological Office is responsible for rainfall survey, the Geological Survey for underground water and the Minister of Local Government and Planning and the Secretary of State for Scotland for surface water survey. The information these survey organisers need is provided by a variety of public and private undertakings and private individuals. However, only well owners and the river boards in England and Wales are under any statutory obligation to measure and record in a manner and for a period wholly adequate for survey purposes. The report is entitled "Inland Water Survey Committee Fifth Annual Report, 1950," and is obtainable from H.M. Stationery Office.

The B.S.I. Golden Jubilee

AT a banquet given in London to celebrate the golden jubilee of the British Standards Institution last week, the Chancellor of the Exchequer announced the acceptance by the Government of the recommendations contained in the Cunliffe report, which was set up to consider the organisation, constitution and finance of the Institution. The Chancellor said that the Government recognised that a continuing financial contribution, based upon the amount of industrial subscriptions was desirable. But he pointed out that, in view of the uncertainty of the future, the Government could not be committed for the full five-year term proposed in the report. It was, however, prepared to be committed for three years, on the basis that the matter would be considered further at the end of that time. This proposal had been accepted by the Institution. The Chancellor went on to remind his listeners that many grave difficulties had arisen in recent months and would no doubt continue for a time because the manufacturing capacity of the free world appeared to be out-running the supply of raw materials. He pointed out that there was some danger that shortages of raw materials might lead to a feeling in some quarters that it was no longer worth bothering about higher production. This, he said, was, in his view, quite wrong, as productivity should not be regarded solely as a means of saving manpower but also of economising in raw materials themselves. In that direction the B.S.I. could do much to help industry to do with less of particular materials by revision of standards and substitution of alternative materials, wherever possible. In a later speech the Minister of Supply paid tribute to all associated with the Institution for the work they had done towards the economic progress and the standards of efficiency in this country.

The Export Group for the Construction Industries

AT the banquet of the Export Group for the Construction Industries, which was held at the Savoy Hotel, London, on Wednesday, June 20th, the toast of "Overseas Contracting" was proposed by Sir Hartley Shawcross, President of the Board of Trade. Sir Hartley spoke of the formation of the Group in 1940 and of the economic difficulties which had to be faced to-day in increasing exports at the same time as carrying out the rearmament programme, which, he said, was going to occupy up to 25 per cent of the capacity of the engineering industry. Unfortunately, he continued, it had been necessary to issue an order controlling the export of steel, which was bound to affect in some measure the activities of the Group but he had every confidence that its members would be able to continue the important contribution to export earnings which they had already made—in fifty countries or more the Group had been earning in all forms of constructional work an annual amount of between £30 and £50 million. Sir Godfrey Mitchell, chairman of the Group, replied to the toast, and the toast of the guests was then proposed by Sir Albert Braithwaite. Major-General Clive Steele responded, and spoke of the importance of Australia as a potential market for a body such as the Group and of the conditions governing industrial activity in Australia at the present time.

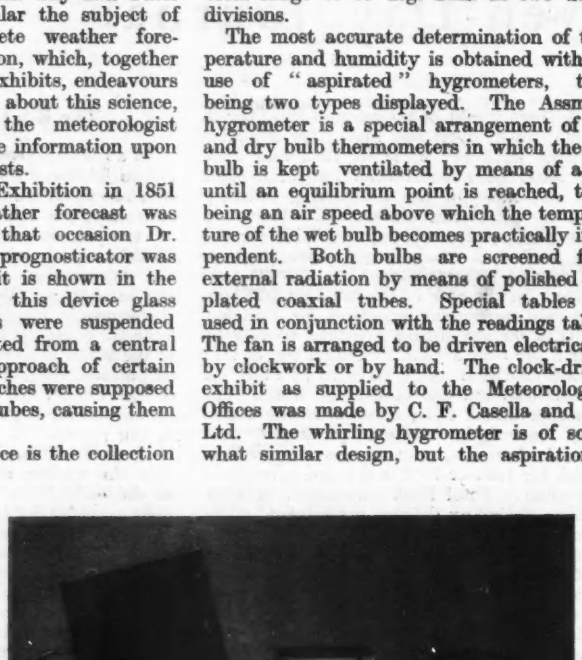
The South Bank Exhibition

No. IX—(*Continued from page 817, June 22nd*)

THE first gallery in the Dome of Discovery, having as its theme the Sky and Outer Space, covers in particular the subject of meteorology. A complete weather forecasting unit is in operation, which, together with other displays and exhibits, endeavours to explain what is known about this science, and in what manner the meteorologist collates and interprets the information upon which he essays his forecasts.

It was at the Great Exhibition in 1851 that the first daily weather forecast was ever produced, and on that occasion Dr. Merryweather's tempest prognosticator was displayed. A model of it is shown in the Dome of Discovery. In this device glass tubes containing leeches were suspended from radial arms supported from a central column, and with the approach of certain weather conditions the leeches were supposed to climb the neck of the tubes, causing them to be dislodged.

In contrast to this device is the collection of present meteorological appliances grouped on this gallery. The instruments for recording the primary meteorological elements of pressure, temperature and humidity include those used for direct visual observations and others which are self-recording. A continuous record is obtained with these latter instruments, from which may be taken instantaneous absolute readings of the element recorded, but the record is normally used to interpolate the intervals between the readings taken visually on standard instruments.



THERMOGRAPH

The recording barograph exhibited is made by Short and Mason, Ltd., and depends for its action upon the dimensional changes of a one-piece multi-corrugated vacuum pile of a design which is stated to eliminate hysteresis effects. Vertical height changes of the pile during air pressure variations are transmitted to the pen arm by a suitable arrangement of two horizontal levers linked by a vertical pin. The second lever actuates a horizontal bar carrying the pen arm, which registers on a revolving clock drum; this arm is mounted in the manner of a gate, but with the hinge axis adjustably inclined. The movement aims also to compensate for temperature effects.

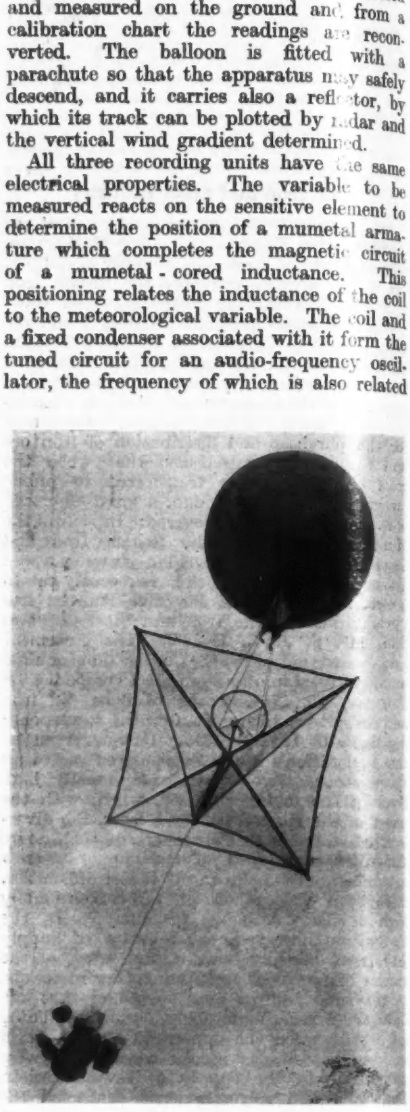
Continuous temperature records are obtained with the thermograph, of which the actuating element varies with different forms, some for distant reading purposes. One instrument exhibited and supplied by Short and Mason, Ltd., employs as the expansion agent an exposed laminated bimetallic coil, to the free end of which is attached a stylus. The stylus registers on an enclosed clock drum and is hinged to the coil through a gate suspension system, as incorporated in the barograph as can be seen in our first illustration, the slope of the hinge plane determining in a positive and sensitive manner the pressure of the pen on the chart. Time ordinates are curved to conform with the loci of the stylus, and the instrument, which is fitted with a seven-day clock, has a total range of 80 deg. Fah. in two degree divisions.

The most accurate determination of temperature and humidity is obtained with the use of "aspirated" hygrometers, there being two types displayed. The Assmann hygrometer is a special arrangement of wet and dry bulb thermometers in which the wet bulb is kept ventilated by means of a fan until an equilibrium point is reached, there being an air speed above which the temperature of the wet bulb becomes practically independent. Both bulbs are screened from external radiation by means of polished and plated coaxial tubes. Special tables are used in conjunction with the readings taken. The fan is arranged to be driven electrically, by clockwork or by hand. The clock-driven exhibit as supplied to the Meteorological Offices was made by C. F. Casella and Co., Ltd. The whirling hygrometer is of somewhat similar design, but the aspiration is obtained by whirling a suitably mounted frame by hand and the bulbs are therefore not as effectively screened from radiation.

The exhibits include a hair hygrograph used for obtaining a continuous record of humidity. The actuating element consists of strands of human hair, freed of fat content. The length of such a hair, for practical purposes, varies non-linearly with relative humidity and is unaffected by other meteorological elements. The movement amplification depends on a simple lever and cam principle, the hairs being fastened at their ends and caught up in the middle by a hooked lever which is under slight spring tension. This lever embodies a cam piece, which makes contact with a second cam attached close to the fulcrum of the pen arm, the other end registering on a clock drum enveloped by a suitably calibrated chart.

Of considerable value to the meteorologist is knowledge of the state of the air other than that near the ground. Apart from certain actual flight investigations, this information is now largely obtained by use of the Radiosonde. This is an apparatus carried aloft by a balloon from which are suspended, complete with telemetering equipment, instruments for registering pressure, temperature and humidity. Our illustration shows the Radiosonde during an ascent. The reaction of the recording instruments during the ascent is translated into electrical signals in the audio-frequency band. These signals, which are alternately selected by a switch rotated by a windmill on the container, modulate a radio-frequency transmitter and are radiated to the ground station. The audio-frequency component is detected and measured on the ground and from a calibration chart the readings are reconverted. The balloon is fitted with a parachute so that the apparatus may safely descend, and it carries also a reflector, by which its track can be plotted by radar and the vertical wind gradient determined.

All three recording units have the same electrical properties. The variable to be measured reacts on the sensitive element to determine the position of a mumetal armature which completes the magnetic circuit of a mumetal-cored inductance. This positioning relates the inductance of the coil to the meteorological variable. The coil and a fixed condenser associated with it form the tuned circuit for an audio-frequency oscillator, the frequency of which is also related to the meteorological variable. The temperature unit employs a split cylinder of steel-invar bimetal and has a range of ± 120 deg. Fah., being accurate to $\pm 0{\cdot}7$ deg. Fah. The aneroid capsule of the pressure unit has an unavoidable temperature coefficient, which is corrected by a special slide rule. Pressures from 30–1050 millibars can be recorded to within ± 5 millibars.



RADIOSONDE

The actuating element in the humidity recorder is a length of goldbeaters' skin under tension, the length of which varies with relative humidity. It can register from 0–100 per cent and is accurate to within ± 5 per cent relative humidity. The telemetering system consists of a radio transmitter operating in the range 27–30 Mc/s, and a small combined high and low-tension accumulator, the range is in excess of 100 miles.

At the normal rate of ascent the rotating switch makes about 3 r.p.m., giving six to seven seconds for each reading.

The Radiosonde balloon is inflated with hydrogen and has a free lift (in excess of the weight of the apparatus) of about 1250 grammes, giving an ascent rate of 1000ft per minute. The balloons as supplied by

Philips Patents, Ltd., are of seamless construction in natural rubber latex. Two sizes of balloons are in general use and their normal weights are 500 grammes and 350 grammes. The heavier balloon has a diameter at ground level of 5ft 11in and attains a height of 60,000ft before bursting, its diameter then being 13ft 2in.

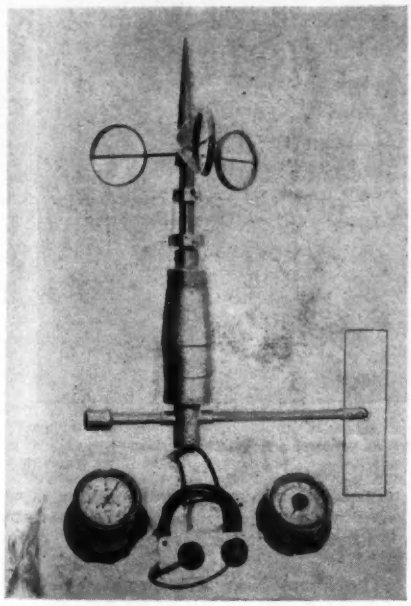
When a Radiosonde is used in bright sunlight errors may occur due to the balloon being warmed by solar radiation and leaving a heated wake. To eliminate these errors a small winch is used, which slowly pays out an additional length of suspension as it travels upwards. The aerial is a half-wave end-fed type coupled to the oscillator through a small condenser to minimise the loading on the oscillator, and it is constructed to serve also as a suspension for the Radiosonde. The current in the centre of the aerial is 15mA to 20mA. The aerial consists of a core of twisted nylon, which holds the Radiosonde, and this is enclosed in plated copper sleeving. The terminal for attaching the aerial is arranged to switch on the Radiosonde when the aerial is connected.

The radio receiver and oscilloscope unit comprises a superheterodyne radio set of adequate sensitivity, covering a frequency range corresponding to that of the Radiosonde. A cathode-ray tube indicates the output and provision is made for injecting the output voltage of a calibrated source on the horizontal deflector plates to enable audio-frequency to be determined by Lissajous figures.

The total weight, excluding the balloon, is approximately 1400 grammes.

Wind Measurement

An electrical wind direction indicator and cup anemometer is exhibited which is made by R. W. Munro, Ltd. This instrument is used in situations where a remote



Wind Velocity Indicator

indication of wind speed is required. A permanent magnet generator is built into the head and protected against weather. Three conical perspex cups are fixed to detachable arms which are secured to the top cap by separate bronze bolts. When the cup spindle is rotated an alternating current is induced in the stator windings and this current is used to operate one, two or three indicators, connected in parallel. These indicators incorporate metal rectifiers and temperature correcting elements, and are calibrated to read wind speeds. Mounted co-axially with this unit is the electrical wind direction indicator, and remote readings are obtained on dial indicators of the "desynn" type. The head, which houses the transmitter and cardinal points, is fitted

Sunshine Recorder

with a ball-bearing plastic vane. The instrument illustrated is similar to that installed on the top of the Skylon.

Instruments for measuring cloud direction included the Besson nephoscope. This form of nephoscope consists of a metal comb about 3ft 6in long, mounted on a vertical rod 7ft 6in in height. To find the direction of motion of a cloud the observer moves until the cloud selected is in the same straight line as the central spike. The crosspiece is then rotated until the cloud appears to travel along the line of spikes in the direction of the arrow, the cloud direction being then read on the divided circle. The velocity height ratio is obtained by noting the time taken for the cloud to pass from spike to spike, and from a knowledge of the spike intervals, along with the distance from the top of the central spike and the observers' eye-level. The formulæ used enables cloud velocity to be calculated providing the height is known.

Amongst the other instruments displayed is a Campbell-Stokes sunshine recorder, which is illustrated herewith. It employs a glass sphere to focus the sun's rays and burn a trace on a specially treated card mounted in a partly spherical metal bowl. The instrument is accurately levelled from east to west and exposed so that at all times of the year no obstruction will prevent the sun's rays reaching the instrument. It must face due south in the Northern Hemisphere and due north in the Southern Hemisphere, so that at noon, local apparent time, the sun will focus on the noon line of the card when this line is opposite the noon line on the bowl. The frame and sphere are adjustable for latitude and concentricity.

Weather Forecasting

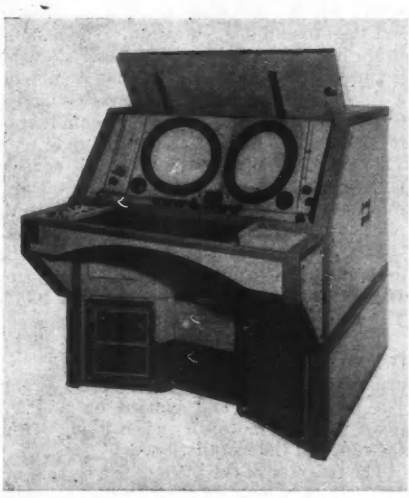
The weather forecasting unit on this gallery in the Dome of Discovery demonstrates how the information obtained with meteorological appliances is collected, recorded and analysed. There are illuminated wall maps showing the location of weather reporting stations in the Northern Hemisphere and illustrating the network of radio and teleprinter facilities by which coded weather reports are sent to the Central Forecasting Office at Dunstable. On these maps are indicated also the positions of the meteorological stations afloat in the Atlantic Ocean, of which Britain maintains two, and of other stations where radiosonde and flight investigations are carried out.

At this unit the weather maps can be seen plotted and twenty-four-hour weather forecasts are compiled and sold to visitors.

Flight Navigational Radio Aids

Meteorological information is particularly essential in the field of air transport, in which sphere certain weather hazards still constitute one of the major problems. The existence of cloud or radiation fog on the ground at landing areas and its frequent extensive development over air routes are conditions for which a wide range of radio equipment has been developed. A selection of this equipment is demonstrated in the Transport Pavilion, and these units may be broadly divided into two groups, one consisting of navigational aids for use *en route* and the other including blind approach and landing aids. With a combination of such aids it would be possible, ideally, for certain aircraft to carry out a complete flight without visual contact with the ground, but other factors render necessary the observance of operational limits of cloud base and forward visibility.

The separate elements which constitute the British Ground Control Approach (G.C.A.) equipment are displayed. This equipment consists of the precision approach radar (P.A.R.) equipment and an element known as the surveillance radar. The P.A.R. equipment forms a precision "talk-down" aid for landing aircraft, and, as distinct from wartime equipment, is remotely operated from the control tower. The equipment displayed



P.A.R. Display Consoles

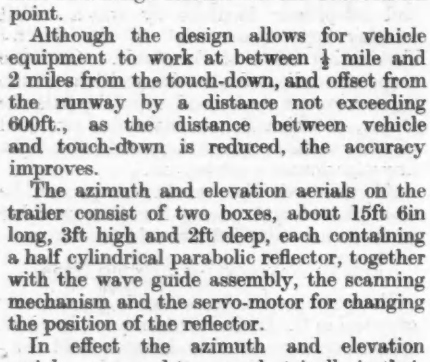
is that developed by Standard Telephones and Cables, Ltd., and it comprises three main units: the trailer equipment, containing the radar transmitters and receivers, together with their associated elevation and azimuth antennæ and part of the radio link equipment; the control tower terminal equipment, situated in the equipment room of the control tower and consisting of racks housing part of the radio link equipment, distribution units, control and monitoring racks; and the display consoles (up to four in number), situated in

the control room and providing information of the aircraft's position in azimuth, elevation and range relative to the touch-down point.

Although the design allows for vehicle equipment to work at between ½ mile and 2 miles from the touch-down, and offset from the runway by a distance not exceeding 600ft., as the distance between vehicle and touch-down is reduced, the accuracy improves.

The azimuth and elevation aerials on the trailer consist of two boxes, about 15ft 6in long, 3ft high and 2ft deep, each containing a half cylindrical parabolic reflector, together with the wave guide assembly, the scanning mechanism and the servo-motor for changing the position of the reflector.

In effect the azimuth and elevation aerials are caused to scan electrically in their respective planes and within angular limits,



I.L.S. RECEIVER EQUIPMENT

about a glide path elevated at 2·5 deg. The elevation aerial uses a beam subtending 4 deg. in azimuth and 0·5 deg. in elevation (measured at 0 deg. elevation), with which to scan vertically through −1 deg. to +6 deg. elevation. The azimuth beam has the same fixed characteristics, but is turned through 90 deg. so that it subtends a fixed angle of 4 deg. in elevation and of 0·5 deg. in azimuth. With this beam it scans in azimuth ± 10 deg. about the glide path. The aircraft's presentation on the consoles is such that when within 4500ft its distance relative to the glide path can be stated to the pilot to within ±10ft in elevation and ±25ft in azimuth, whilst the range can be determined to ±120ft within distances from 12,000ft to the minimum range of 1000ft. The maximum range is 60,000ft.

The surveillance radar element of British G.C.A., made by A. C. Cossor, Ltd., is a primary radar system by which all aircraft can be identified and plotted on a P.P.I. (plan position indicator) when flying within the range of the installation.

The reflector of the scanner is a section of a 10ft (32 wave lengths) focal length paraboloid which is asymmetrically placed with respect to the pole of the paraboloid, the pole being 3ft from the bottom edge of the section. The aperture of the section is nearly 14ft.

The feeder consists of ten slots in a 3in by 1½in wave guide which is curved. Each slot feeds a horn, the first horn being at the focus of the paraboloid; 80 per cent of the power is radiated from the first two horns, the remainder shaping the beam to a cosecant pattern. The vertical coverage of the radar beam extends from an angle of elevation of ½ deg. up to 30 deg. The system is designed to give a range of 25 miles for the smallest aircraft with a top cut-off at 10,000ft. Larger aircraft will be seen at correspondingly greater ranges. The horizontal beam width is rather less than 2 deg. The system allows the position of an aircraft to be estimated to ±1 deg in azimuth and to ±1 per cent of its range or ±¼ mile. Two aircraft can be resolved on the same bearing when separated by a quarter of a mile in range and at the same range when separated by 2 deg. in azimuth.

The equipment incorporates a system of permanent echo cancellation. Its purpose is to reduce the clutter caused by ground echoes, by discriminating against them in favour of moving targets. The moving target indicator (M.T.I.) system depends on the fact that moving objects will travel a considerable part of a wavelength between successive pulses, whereas fixed objects will show no change of phase from pulse to pulse. The M.T.I. system, therefore, employs a phase-sensitive receiver, the output of which provides signals varying in amplitude according to the difference in phase between the "echo" and a reference frequency.

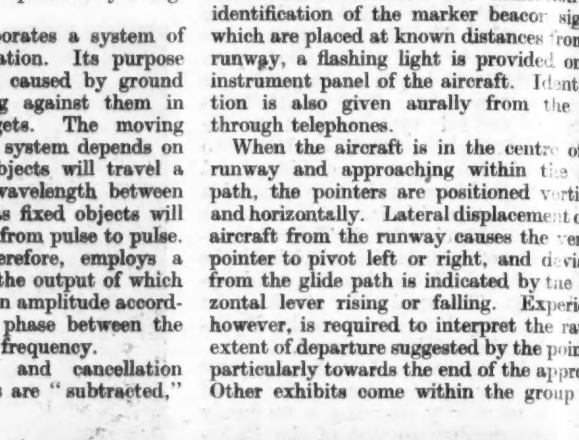
Using a delay line and cancellation circuits, successive traces are "subtracted," so that the fixed echoes are "cancelled" but the moving targets are indicated by a residual signal." Video mapping" is used to add selected information to the P.P.I. display, so that routes and obstruction points can be indicated.

To identify aircraft the bearings obtained automatically by a cathode ray direction finding equipment (C.R.D.F.) working in the very high-frequency band are electronically superimposed on the P.P.I. display. When any aircraft calls on the selected frequency a radial trace on the P.P.I. intersects the echo from the calling aircraft. The centre of rotation of the P.P.I. trace is offset to allow for the distance between the radar scanner and the C.R.D.F. aerial system.

Provision is made for three independent displays. Range scales of 0 to 8, 16, 24 and 48 miles are provided with range marker rings at 1-mile intervals on the two shorter ranges and at 4-mile intervals on the two longer ranges. Azimuth markers appear at 10 deg. intervals.

As distinct from ground control approach techniques there is exhibited a radio approach aid in which the pilot during the runway approach is solely responsible for the interpretation of visual and aural position indicators, contained within the cockpit. This equipment is also made by Standard Telephones and Cables, Ltd. The system comprises three ground based transmitting elements for the runway localiser, the glide path and marker beacons and two airborne receivers, type "SR14/15," along with a single flight indicator and control box. Any one of twelve pairs of localiser and glide path frequencies can be selected by operation of a single rotary switch on the control unit. As the marker receiver is set to operate on one frequency only, this operation, together with switching "on" at the control unit is all that is required for a particular approach. An indicating crossed-pointer is used, the horizontal needle of which is operated by the glide path receiver, and the vertical needle by the localiser receiver. For indication and identification of the marker beacon signals, which are placed at known distances from the runway, a flashing light is provided on the instrument panel of the aircraft. Identification is also given aurally from the tone through telephones.

When the aircraft is in the centre of the runway and approaching within the glide path, the pointers are positioned vertically and horizontally. Lateral displacement of the aircraft from the runway causes the vertical pointer to pivot left or right, and deviation from the glide path is indicated by the horizontal lever rising or falling. Experience, however, is required to interpret the rate or extent of departure suggested by the pointers, particularly towards the end of the approach. Other exhibits come within the group concerned with airborne direction finding equipment with which rapid or instantaneous position indications are obtained during flight.



RADIO INSTALLATIONS IN THE "COMET"

The Decca Navigator aircraft equipment depends on what is known as the hyperbolic system of radio position fixing. The system employs a chain consisting of a master transmitter normally transmitting a frequency-stable continuous wave, and three slave stations (red, green and purple) transmitting on their respective frequencies and accurately phase-locked to the master signal. In this manner radio position lines are created in the form of families of hyperbolæ.

The function of a Decca receiver Mk. VI is to measure accurately the phase differences between pairs of signals and to display each

difference value on a "Decometer" indicator. There are three "Decometers," relating to the master/red, master/green and master/purple combinations of transmitting stations. The "Decometer" scales are marked numerically to correspond with the numbered in-phase hyperbolæ which form the Decca position lines on maps and charts. In this way the three "Decometers" record the aircraft position at any instant. To this equipment has been added the Decca flight log, which automatically and continuously pinpoints and traces on a map an aircraft's exact position and the track made good.

The flight log is based upon the principle of converting the rotation of the Decometers to interpret their indications on a map by means of a cursor moving across it. This is the function of the torque converter unit, which consists of three motors with associated gearboxes controlling the movement of the display unit in both axes.

The display unit consists of a map viewed through an aperture 10in by 4in across, which traverses a perspex cursor carrying a small stylus. This part of the equipment may be installed on the dashboard for the captain or the navigator. The unit is driven by two motors, operated and controlled by the torque converter, which feed the strip map through the display head and cause the cursor to move across the visible portion of the map. Thus the map is moved on one axis while the cursor is made to move across the map on the transverse axis, according to the aircraft's movement through the Decca space patterns.

Electrical impulses cause the cursor to indicate selected time intervals along the track made good, so that by observing the distance between six-minute intervals the ground speed can be determined and the time of arrival simply estimated.

The entire Decca airborne equipment weighs less than 125 lb and occupies about 3 cubic feet.

The English navigational Decca chain has been used since 1948 by the Central Photographic Establishment, R.A.F., for precise tracking in aerial photography for the Directorate of Ordnance Survey, which is an indication of the standard of accuracy attained. The range of the system is independent of aircraft height, and the authorised day and night range from the master stations of the English and Danish chains is 240 nautical miles for surface vessels (nearly 1000 of which are using the service). The coverage is being supplemented by the provision of further chains in Great Britain and in Europe.

The Marconi equipment exhibited includes the h.f./m.f. high-power aircraft transmitter, type "AD107," the "AD108" receiver, and the "AD7092A" automatic radio compass and suppressed direction finding loop. The transmitter has ten preset crystal controlled channels and has an output of 80–150W, h.f. and 50–120W, m.f. It incorporates a special form of buried antennæ. This equipment was fitted to the "Canberra" during its Atlantic crossing, and it was stated to be in perfect communication when at a distance of 1500 miles.

This equipment is shown in our illustration amongst the wireless communication and navigational aid installations as presented to the operator in the "Comet" aircraft.

(To be continued)

The Iron and Steel Institute

No. IV—*(Continued from page 837, June 22nd)*

ON Thursday afternoon, May 31st, there were four papers presented for joint discussion. A synopsis of each paper is reproduced herewith, followed by abstracts of the discussion.

THE SMIDTH AGGLOMERATING KILN

By W. E. Simons

Synopsis

The rotary kiln provides an alternative method to sintering for the treatment of fine ores and flue dust. The construction of a particular kiln and the lay-out of the plant are described.

The operating procedure is outlined and details, including analyses, are given of the ingoing materials and of the finished agglomerate; some of the difficulties and hazards of the process are mentioned. Data are given relating to the use of the agglomerate in the blast-furnace, and the advantages and disadvantages of the rotary kiln are discussed. The Smidth rotary kiln described in the paper was installed in 1938 and commenced production in February, 1939. It was designed to use 100 per cent flue dust, of which there were considerable reserves in the district. These stocks have now been consumed and the present practice is to use about 35 per cent flue dust, the balance being fine ore and pyrites. The output of the plant is of the order of 3000 tons of agglomerate per week.

SINTER MAKING AT APPLEBY-FRODINGHAM

By G. D. Elliot and N. D. Macdonald

Synopsis

A large-scale plant research has been carried out with the aim of improving the quality of sinter manufactured from Frodingham and Northampton ironstone fines. Several aspects of plant, raw materials and practice are briefly dealt with; the effects of return fines, which are shown to be of great importance in sinter making, are discussed at greater length. Arising from this work, modifications are being made to a new sintering plant that is being built. These are mentioned but are not described.

DEVELOPMENT OF EXPERIMENTAL SINTER PLANT AND PRELIMINARY RESULTS USING NORTHANTS ORE

By E. W. Voice, B.Sc., A.Inst.P.; C. Lang, B.Sc., and P. K. Gledhill, Ph.D.

Synopsis

A sinter pan 2ft square was set up using suction from a production sinter plant, a separate fan being later erected to give controlled suction up to 32in W.G. Sinter was produced from weighted mixes, the sinter process was observed and the sinter made was assessed for physical properties. Results showed agreement with previous data obtained on the full-scale sinter plant and, owing to the closer control and greater flexibility attainable with the small unit, quantitative results were achieved showing the effects of flue dust, returned fines and coke on the sinter strength. Correlation was obtained between moisture content and suction on the speed of sintering, and observations were made of bed porosity and air flow before and during sintering. The effects of various fuels were also studied.

THE SINTERING OF NORTHAMPTONSHIRE IRON ORE

By D. W. Gillings, Ph.D., A.R.I.C., F.Inst.P.; E. W. Voice, B.Sc., A.Inst.P.; C. Lang, B.Sc., and P. K. Gledhill, Ph.D.

Synopsis

The No. 3 sinter plant at the Corby works of Stewarts and Lloyds, Ltd., was made available to a team of investigators from the British Iron and Steel Research Association for full-scale experiments designed, to determine the factors which control the quality of sinter made from Northamptonshire iron ores. In order to determine as far as possible a method of assessment of sinter quality, a rudimentary analysis was made of data on the use of sinter of known properties in the burdens of several blast-furnaces and this emphasised the importance of physical properties. From the results of experiments carried out on the sinter plant it was possible to determine the effects and relative importance of the factors governing the physical properties of the sinter. The control of proportions and properties of raw materials was most important, the carbon content of the raw mixture being especially critical. The efficiency of mixing and the exclusion of large fragments of ore and coke were next in importance, followed by control of content of returned sinter and of water in the mixed raw materials. Variations of suction had very little effect over the range of values encountered on the plant concerned.

Discussion

Dr. T. P. Colclough (British Iron and Steel Federation): I should like to give an indication of the magnitude of the problem with which we are faced. The sinter plants which were installed and operating in 1949 dealt with over 4,000,000 tons of material, and produced just over 3,000,000 tons of sinter. The plants which are in process of erection and due to come in before the end of 1952 will, we anticipate, be able to raise that total to about 7,000,000 tons of ore fines, producing 5,250,000 tons of sinter, an increase of roughly two-thirds over our present capacity. That is an indication of how far we have gone in dealing with the problem. If we implement the development programme for this country, to bring us up to about 20,000,000 ingot tons in the year 1960, we estimate that the total amount of ore which will be required, both home and imported, will be of the order of 32,000,000 tons, and, on the assumption that 30 per cent of that will require sintering, we must have a capacity of between 9,000,000 and 10,000,000 tons of raw material handling, as compared with the present programme of 7,000,000 tons. That indicates how far we have to go.

Messrs. Voice, Lang and Gledhill are to be congratulated on establishing the first experimental sinter unit of B.I.S.R.A. It has been recognised for a long time that an experimental unit was necessary. In the early days of our work on sintering in this country we had to take our ore samples over to Germany to have them tested on the experimental units in that country. It is high time that we had a central station in this country to which we could apply for fundamental work of this sort. I would suggest that the B.I.S.R.A. team should focus their attention at first on making that machine as perfect as possible and settling in their own minds what controls and so on they want to put on it, and what meters, and then, when that is accomplished, each of the large makers of sinter in this country should have their own experimental unit, so that they can test their own blending of materials to get the optimum results. The initial experiments have proved suggestive, and I think that a comparison of the three papers gives us a measure of how far we should have a central testing station and how far we should do practical field tests. I suggest that the central or experimental unit should work out the fundamentals, and then the field tests should be carried out on the basis of how far those fundamentals can be applied to the particular machines that we have.

Mr. Guy Barrett (Follsain Wycliffe Foundries, Ltd.): We have just been told that the country is awakening to the need for taking fines out of blast-furnace burden. I think it was in 1907 that that point occurred to those of us who were working certain furnaces at Ebbw Vale. I got 1000 tons of fine ore and I slop moulded it on the floor to make briquettes and used an old brickworks to do it. It certainly produced a very notable improvement, but the cost was too great. We therefore hired a rotary furnace in

Rochester, and we sent 1000 tons of Sierra Minera ore there.

If there is anything that a rotary kiln can do, short of standing on end, that kiln did it. We had every conceivable trouble with it, but we did make nodules, and it was quite evident that we should have a good product if we could do the work properly. We did not get the solution, and then sintering came along and we had the Dwight-Lloyd and the Greenawalt apparatus. In 1919 I was running a small Greenawalt plant, about 1 yard square, on Lincolnshire and Northants ores, and we convinced ourselves that we could certainly make a sinter and do it very nicely, and if we mixed the two ores we got along splendidly; but it was evident that the installation of the sinter plant would probably be the easiest part of the process for a long time, because there were notable difficulties in regular operation. I think these papers prove that that has been the experience, but the authors are eliminating the difficulties one by one.

It is, I think, beyond question that sinter, being within reasonable limits a regular product, compared with the ore at any rate, will give improved furnace operation up to a point, but the sintering processes can result, so far as I know, in the return of a considerable quantity of fines, and that is surely a very wasteful process. It is fairly evident that if the rotary kiln can be made to do the job properly it is a more suitable tool and more likely to give a regular product.

Mr. E. H. Lewis (F. L. Smidth and Co., Ltd.): One point against the rotary kiln which has been mentioned is the difficulty in reducing the agglomerate as compared with sinter made on an ordinary sintering plant. We claim for the rotary kiln that it is very flexible in the matter of the raw materials that can be used. Intimate mixing takes place automatically in the kiln, and the water content does not matter, because it is looked after in the kiln. If necessary, the materials can be fed in in the form of slurry, as is done in a cement kiln, or they can be dry. The size of the raw materials does not matter. We consider that the rotary kiln requires rather less continuous control than does a sintering plant.

Mr. E. W. Voice (B.I.S.R.A.): We have had the advantage of hearing three papers on sinter at one meeting. They are quite different papers, but on the whole there is considerable agreement in their findings. Dr. Gillings and his co-authors show that the greatest effect on sinter quality—presupposing that the material is well mixed, because that is general—of all the controlled variables was due to the percentage of coke; while Mr. Elliot and his colleagues show that the greatest effect was due to the percentage of true return fines. Mr. Lang and his colleagues show in their paper that the percentage of coke, the percentage of return fines and the percentage of flue dust can independently cause the sinter strength to vary from 45 to 80, that is, from rubbish to strong, clean sinter. In fact, there is complete agreement that the less ore you use the better; and this brings us to another point which has already been emphasised, the limitation of the papers to Northants and Lincolnshire ores. The papers have tried to put a precise value to the effect of this and that variation, and it is the precise value that is affected by the type of ore used.

I can give you proof of that, because we have recently used fine Swedish ores on the small sinter box, and we find that sinter made with 20 per cent return fines and 10 per cent flue dust has the same high strength whether 2 per cent, 3 per cent, 4 per cent or 5 per cent of coke is used. This is in complete contrast to the results obtained with the Northants ore used on this small box at Corby. Moreover, we had the same strength of sinter whether 20 per cent, 30 per cent, 40 per cent or 50 per cent of return fines was used with this Swedish ore. We must therefore emphasise the question of the ore which is being used, because the quantitative effect will depend on the ore. Hammer milling improved the quality at Corby. Elliot and Macdonald crush the stone to ¼in in order to reduce the size range of raw materials, and we find that with fine Swedish ore the use of crushed return fines did not greatly affect the speed of sintering until the average size of return fines was below ¼in.

I should like to refer to the question of the effectiveness of the coke in the flue dust. It was said to be 60 per cent effective as carbon. We are not suggesting that the carbon does not burn fully; we do not know; but in our curves we show an increase in strength with increasing coke content, and we also show a curve giving the effect of flue dust, the curve rising rather more steeply and then falling off. It is possible to compare these two curves from the point of view of carbon, and that is what we did. By adding flue dust to the precise mixtures which we were using we were at the same time adding carbon in the form of carbon in the flue dust. You can see how far up the curve you go by adding a certain amount of flue dust, and then see whether, if you add a corresponding amount of carbon on the coke curve, you rise to the same amount or less. We found that the carbon content of the flue dust was only 60 per cent as effective as if the carbon had been added in units of coke.

Mr. T. W. Thursfield (Gjers Mills and Co., Ltd.): It has been mentioned in all these papers on sinter that the authors consider some improvement necessary in the revolving table and plough feeding the mixture belt. We have had precisely the same view, and in that connection were particularly interested in improving the breeze portion of the sinter mixture. It has been found difficult to adjust this breeze feed on the ordinary rotary table, due mainly to the varying angle of repose of the material, particularly with the purchased breeze, containing a vast range of moisture content and particle size. Although our breeze is screened through ⅛in, oversize pieces of material persist. I should explain that we are sintering 100 per cent Sierra Leone concentrate, and the breeze portion of the mix is of the utmost importance. If we go above the limit we get slagging; if we go below we get very little sinter. We therefore introduced a feeder which is used in a number of other processes for a different purpose altogether, the Millar feeder. As far as we know there is no other sinter plant with a feeder of this description. The principle of the working of this feeder appeared attractive to us, as it is not dependent on the moisture content or the angle of repose of the material, and it appeared that it would deliver a measured quantity regularly, without any hanging up in the bunker.

Mr. R. P. Towndrow (Colvilles, Ltd.): It seems to me probable that some of the phenomena in a sintering plant are analogous to the phenomena in a blast-furnace. A sinter plant, like a blast-furnace, is a machine for burning coke, and it probably has a Rice formula which will tell you how much coke you can burn in it. The important point to determine is whether our existing plants are burning as much coke as they can; if not, we have to give them more air so that they can burn more coke. I should like that point to be cleared up.

At the concluding session of the meeting on Friday morning, June 1st, the following papers were jointly discussed:—

FULL-SCALE BLAST-FURNACE TRIALS

By J. A. Bond and T. Sanderson

Synopsis

A study has been made of full-scale trials carried out at the Appleby-Frodingham and Workington branches of the United Steel Companies, Ltd. Details are given of selected trials, showing the benefits to be derived from better selection and preparation of raw materials, ore and coke, and from the use of increased amounts of sinter in the burden. Brief reference is made to attempts to improve the distribution of the burden by alteration of design and to accelerate reduction by means of steam injection, thereby promoting smoother blast-furnace operation and increased output at a lower coke consumption. The main object of the paper, however, has been to demonstrate that full-scale trials are practicable in a large organisation without undue disruption of the normal routine and output of the plant. It is emphasised that such trials require careful planning and subsequent statistical interpretation.

DISTRIBUTION OF MATERIALS IN THE BLAST-FURNACE

Part III—Further Factors Influencing the Distribution of Solids in the Blast-Furnace

By R. Wild, Ph.D.

Synopsis

Previous studies on the distribution of materials in the blast-furnace are extended to further consideration of the effects of modifications in (1) design and operation of the headgear, and (2) the nature of the materials charged. Conclusions drawn from the investigation are enumerated.

Discussion

Mr. J. H. Patchett (Dorman, Long and Co., Ltd.): It is now generally accepted that the elimination of fines and large lumps of material from the blast-furnace does give more economical and smoother furnace operation. This results in a lower coke rate and consequent greater output and better and more regular quality of iron, as well as less loss of iron in the form of flue dust. How much the output of iron can be increased beyond that automatically obtained by the reduction in coke consumption, whilst retaining the same rate of burning coke, without suffering the loss of some of the coke rate production, is a matter which has still to be proved. It has been said in some quarters that high-pressure blowing will obviate the necessity of burden preparation. I do not accept that view, and certainly the evidence does not support it. The evidence on high-pressure blowing is that it gives an increase in output. It is hoped that it will give a reduction in coke rate, but the evidence up to now is very small, and the evidence on ore preparation is that, to my mind, the biggest factor is the saving in the coke rate.

Mr. R. P. Towndrow (Colvilles, Ltd.): I should like to talk for a few moments about experiments and statistics. We are all aware of the difficulties of carrying out an experiment on a blast-furnace. An experiment in the classical sense usually consists of altering some condition from A to B and observing the result change from X to Y, and then changing conditions back from B to A and seeing the result turn back from Y to X. This presupposes that it is possible to control all the variables except the one which is being deliberately changed. It is only rarely, however, that it is possible to do this on a blast-furnace, and therefore the interpretation of the results of any trial, or, indeed, of any operation, on a blast-furnace is difficult. In the past, all blast-furnace operators resorted to the rather crude technique of graphical plotting of colossal averages over long periods of time, and so on, but in recent years they have turned to the statistician to aid them in interpreting

the result, so that it is necessary for them to consider what statistics are. A statistical system can manipulate any sort of numbers that you like to feed into it, and it can give you the results of these manipulations only in terms of numbers. Frequently, before you give the numbers to the statistician, you tell him what they represent. It does not matter in the least to the statistician, however, what label you put on them; he manipulates them according to certain rules. If, therefore, the numbers which you give to the statistician are not the right numbers, he cannot produce a result which is in fact true. We therefore come back to the need for carrying out an experiment on the blast-furnace itself, and an experiment which must be very carefully designed. Messrs. Bond and Sanderson have rightly emphasised that aspect of the matter, that they are not very concerned at the moment with the results which they have produced, and they are not very much concerned with proving that sinter or coke does this or that; they are concerned to demonstrate to us that experimental trials on a full scale can give information on which reliance can be placed.

Mr. E. H. Baldwin (Colvilles, Ltd.): In the section of the paper (by Bond and Sanderson) on sinter trials, very complete data are provided for each of nineteen weeks of furnace operation. The authors have used these only to obtain a series of average values, which on page 37 they correct with unspecified constants derived from another source. It is interesting to try an alternative method of interpretation which involves making the fullest possible use of the nineteen weeks' data by employing them to construct a regression equation for the coke rate over the period. I am inclined to think that the latter method is conducive to greater accuracy. Although nineteen weeks is a short period for the derivation of an equation, the same criticism may be levelled at any information derived directly or indirectly from the trial; furthermore, the constants so obtained have the advantage of being directly related to the behaviour of the furnace at that time.

M.V. "Shanklin" for Isle of Wight Service

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

THE Southern Region of British Railways has just added to its fleet the new motorship "Shanklin," to replace the paddle steamer of the same name. Although the new vessel has been alluded to elsewhere as the second "Shanklin," she is actually the third, the first being a small screw steamer operated by the Southsea and Isle of Wight Steam Ferry Company. She was only 90·2ft long and had a breadth of 16·4ft and depth of 7·1ft, her tonnage being 63 gross. Built about 1873, she did not have a long career plying to and from Ryde, for when in 1880 the service of railway steamers between Portsmouth and Ryde was instituted by the London and South-Western Railway jointly with the London, Brighton and South Coast Railway, "Shanklin" had already been disposed of to a Liverpool buyer.

The railways adopted the practice of naming their steamers after royalties and celebrities, mostly duchesses, but when in 1924 the first post-war steamer was added to the Portsmouth fleet, the Southern Railway reverted to the practice of giving place names, and "Shanklin" (Fig. 1) appeared. There was nothing revolutionary about her, as she was very similar to the pre-war steamers. She was built by J. I. Thornycroft Ltd., at Southampton, and engined by D. and W. Henderson and Co., Ltd., Meadowside, her principal dimensions being: length, 190·1ft; breadth, 26·1ft; depth, 8·7ft; tonnage, 412 gross. She was driven by compound diagonal engines with cylinders 27in and 51in diameter with a stroke of 54in, giving her a speed of 14 knots. It will be noticed that the mast was stepped near the bridge to leave the main deck forward free for luggage and mails, which are slung aboard in three-wheeled trollies. During the war she was not taken over by the Admiralty, but with "Portsdown" maintained the services to and from the island. When the "Portsdown" was sunk by a mine the duties entrusted to "Shanklin" were truly onerous.

The paddle steamer seemed so firmly established in Spithead, and so eminently suited to the work that it came as a surprise to learn that the Southern Railway contemplated building motor vessels, with the result that "Southsea"* was put to work at the end of 1948, being closely followed by her sister ship "Brading."

So satisfied was the Railway Executive with the performance of these two ships that it was decided to build the vessel about to be described. In most respects "Shanklin" is similar to the former vessels, but advantage was taken of the experience gained to make modifications which resulted in increased passenger accommodation, and, as will be seen in the illustration (Fig. 2), the lifeboats are raised, and so do not obscure the promenade deck. There is direct reverse to the engines, which is considered an improvement on the gearing in the other ships. Further, she is a one-class vessel, whereas all other vessels have had two classes. The Southampton-Cowes ships of the Southampton, Isle of Wight and South of England Royal Mail Steam Packet Company were arranged to have only one class some years ago, the first class fares being applied.

The principal dimensions of "Shanklin" are as follows: length, 200ft; breadth moulded, 46ft; draught, 7ft; tonnage, 833 gross. The vessel is propelled by twin screws of a diameter of 5ft 5in, and the propeller shaft at 375 r.p.m. imparts a speed in service of 14½ knots. On her trials she attained a speed of 15¾ knots, and in coming round from her builders on the Clyde, Denny Bros., Ltd., she maintained a speed of over 15 knots. Her main engines are two Denny-Sulzer eight-cylinder diesel engines, each of 950 b.h.p. They are two-stroke trunk piston, airless injection units, and the cylinders are 320mm in bore with a stroke of 380mm. Each cylinder is provided with a side scavenge pump driven by rocking lever from the connecting-rod, these pumps having a diameter of 400mm and a stroke of 475mm, each cylinder having its own fuel pump driven from the camshaft. The shafting is carried in Cooper split roller bearings. Auxiliary electrical supplies are provided by three Ruston and Hornsby diesel engines, each coupled to a 60kW Allen generator. Steam for domestic use and heating is supplied by a Cochran boiler fitted with Clyde automatic oil-burning unit. Thermotank ventilation is fitted throughout the vessel, and a public address system has been installed. Newalls Insulation Co. Ltd., has fitted and installed Pax marine insulation in the engine-room, which has reduced

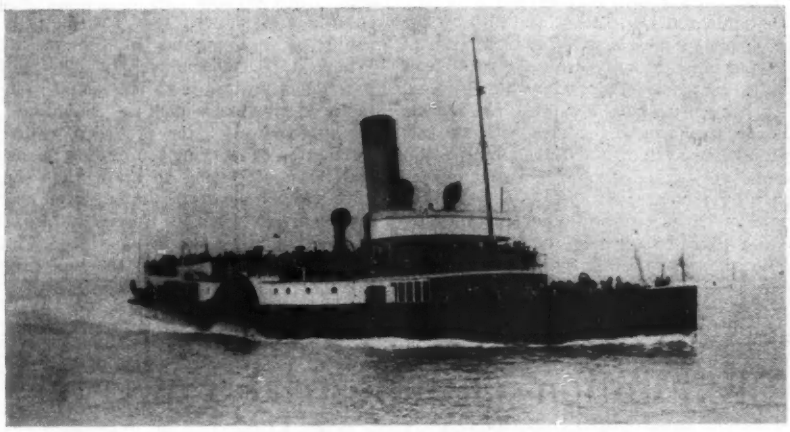


FIG .1—PADDLE STEAMER "SHANKLIN" (1924)

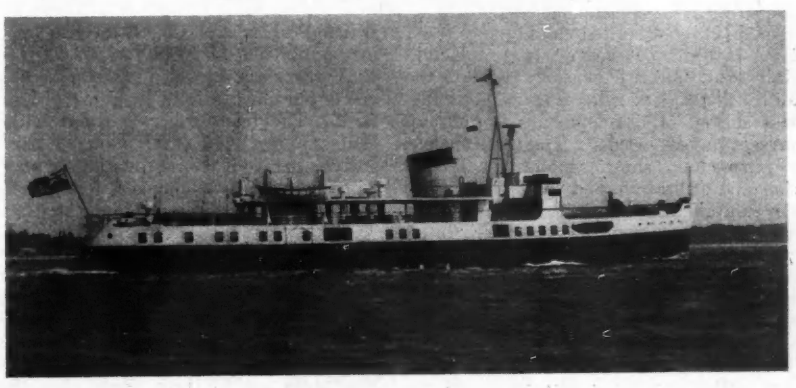


FIG. 2—MOTOR VESSEL "SHANKLIN" (1951)

* Described in THE ENGINEER of November 26, 1948.

the sound considerably, and the smooth running of the engines was noted, the vibration being much less than on many diesel ships.

Among the principal auxiliary machinery may be mentioned: two air compressors by Reavell and Co., Ltd., and also an emergency air compressor; oil fuel purifiers, by MacTaggart Scott and Co., Ltd.

"Shanklin" has a sturdy businesslike appearance with big streamlined funnel, tripod mast, in front of which is the radar scanner, raked stem and cruiser stern. She has passenger accommodation for 1377 passengers and a crew of thirty-three. On the promenade deck there is considerable seating accommodation, a good deal of it being sheltered. The quarters for captain, chief engineer, first officer and second engineer are also situated on this deck. On the main deck will be found a comfortable lounge forward, well equipped lavatories amidships, and towards the stern a large refreshment room, bar and buffet, and a ladies' room. Space in the bows is reserved for baggage and mails, which are lowered through hinged hatches on the promenade deck. There is also a good deal of seating accommodation under shelter, with large windows from which a good view is obtainable. On the lower deck there is good accommodation for the crew forward, behind which is another spacious refreshment room and bar and buffet; then comes the engine-room, and astern of it a comfortable general lounge (Fig. 3), panelled in mahogany.

FIG. 3—GENERAL LOUNGE OF M.V. "SHANKLIN"

A demonstration cruise took place on June 15th, during which it was shown how suitable the vessel is for the work intended. She was brought to the piers without trouble and showed how satisfactorily she could be manœuvred in narrow waters. When it is mentioned that 3¾ millions passengers are taken to the island annually, the need for vessels such as "Shanklin" will be appreciated. Her predecessor had the distinction of carrying ten million passengers, and it is interesting to know that she will have a new lease of life, having been acquired for excursion work by Cosens and Co., Ltd., of Weymouth, to replace the famous "Monarch," whose name she will probably take.

by Sharples Centrifuges, Ltd.; oil coolers, by Serck Radiators, Ltd.; fuel oil booster pumps and fuel oil transfer pump, by Hamworthy Engineering Company, Ltd.; two bilge and general service pumps, each of 45 tons per hour capacity against a total head of 50ft., by Worthington-Simpson, Ltd.; salt water and fresh water circulating pumps, two of the former of 100 tons per hour capacity against a total head of 50ft, and two of the latter of 70 tons capacity against a head of 70ft, by Drysdale and Co., Ltd.; and also by the same firm a domestic fresh water pump of 5 tons per hour capacity against a total head of 80ft. Monitor Patent Safety Devices, Ltd., has provided low-pressure alarms to cover fresh water cooling system, salt water cooling system and forced lubrication systems. All the auxiliary machinery is electrically driven.

Steering is by twin rudders, operated by electro-hydraulic steering gear with telemotor control, the gear being supplied by John Hastie and Co., Ltd., and the telemotors

Exhibition of Industrial Power at Kelvin Hall

No. V—*(Continued from page 834, June 22nd)*

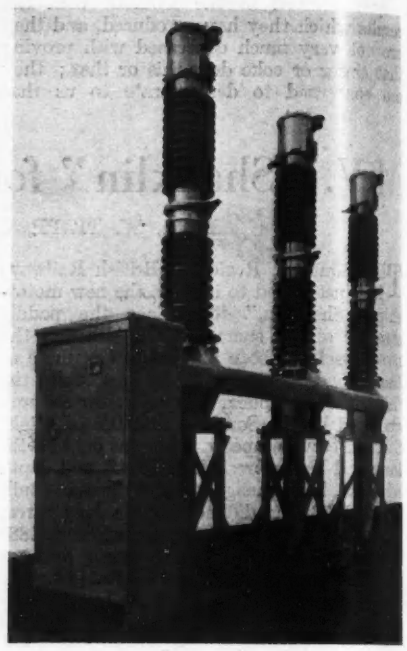
HALL OF ELECTRICITY

IN our introductory survey of the Kelvin Hall exhibition we briefly described the Hall of Electricity, where there is a historical survey of developments leading up to present-day knowledge. The three themes are generation, shown pictorially, distribution and utilisation, and we describe some of the exhibits herewith.

A B.T.H. mercury-arc rectifier rated at 350A., 600V, is shown as a working demonstration. Made from glass having a high percentage of silica to give heat-resisting properties, the glass bulb mercury arc rectifier has high efficiency on light and fluctuating loads. Its maintenance cost is low whilst starting is automatic and the rectifier is ready for load immediately.

Bruce Peebles and Co., Ltd., has supplied for exhibition a 2000kVA, 33,000/11,000/433V transformer, which, as can be seen in one of our illustrations, is shown without its tank. The transformer is fitted with off-load tapping switch for minus 5 per cent and 7½ per cent voltage variation and also with on-load tap changer for ±8·6 per cent voltage variation in twelve steps.

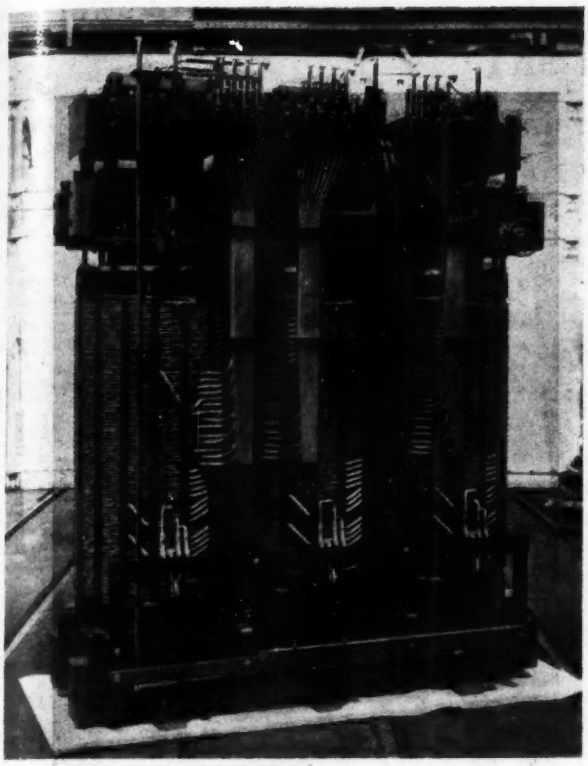
A 132kV, 2500MVA small-oil-volume circuit breaker, manufactured by A. Reyrolle and Co., Ltd., is exhibited and illustrated herewith. It consists of three identical separate single-phase units operated, through a self-aligning rotating shaft, by a mechanism housed in a local control cubicle. The units are in three parts consisting of a supporting compartment, a circuit-breaking compartment and a metal top cap with a gas vent. Inside the supporting compartment is an oil-filled metal base chamber and a porcelain insulator containing the moving contact operating links. Within the circuit-breaking compartment are the upper and lower fixed contacts and through the latter slides the moving contact stem, all the parts being contained in a cylindrical bakelised paper tank surrounded in turn by a porcelain. The oil in the tank is used as the arc extinguishing medium and is separate from the insulating oil filling the supporting compartment and the annular space between the tank wall and the upper porcelain shroud. A silica-gel breather and oil level indicators are fitted to the metal top-cap from which is suspended the upper fixed contact, with its turbulator arc-control device. The breaker is pneumatically closed and spring-opened but for demonstration purposes the contacts of the centre unit are arranged continuously to close and open slowly. Cut-away sections with Perspex windows enable the construction and movements of the contacts and operating links to be observed.



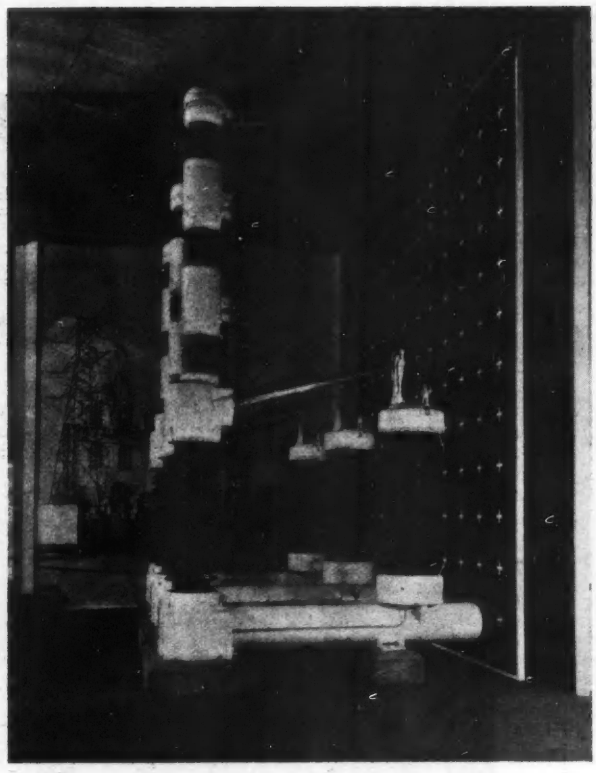
SMALL-OIL-VOLUME CIRCUIT BREAKER

Opposite the small-oil-volume circuit breaker display is a three-phase 165kV, 3500MVA air-blast circuit breaker exhibited by the English Electric Company, Ltd., and set against a mural background, depicting a grid substation, as illustrated overleaf. Normal current is 600A to 800A and the breaking capacity is 12,250A (symmetrical current) and 15,000A (asymmetrical current), while the making capacity peak current is 31,200A.

Each single-phase unit consists of a steel air receiver base upon one end of which is mounted the main interrupter column, made up of hollow porcelain insulators. These support the make-switch operating mechanism and interrupter units complete with cooler and exhaust units, the chamber at the tip of the column being the cooler and exhaust for the uppermost interrupter. Each phase has three interrupter units; they are in series and connected in parallel with them are silicon carbide units which tend to equalise voltage distribution across

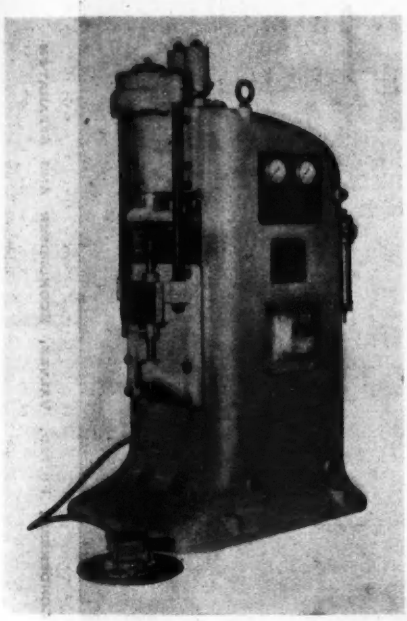


TRANSFORMER WITHOUT TANK



165KV AIR BLAST CIRCUIT BREAKER

the interrupters. At the base of each column is an air-blast valve enclosed in a cabinet, together with high-speed electro-pneumatic control valves. At the opposite end of the base is placed a low-oil-content porcelain-clad current transformer. The insulator cover carries the make-switch



ELECTRIC RIVET HEATING AND UPSETTING MACHINE

fixed contacts, which include the incoming line terminal and a de-icing device to ensure ice-free contacts.

For opening, the coil of the "tripping" electro-pneumatic control valve is energised and opens a valve, which admits air to operating piston of the main blast valve. This piston, having a larger area than the valve, overcomes the pressure exerted on the valve face by the air inside the receiver. The opening of the valve admits a blast of air through the hollow support insulator to the interrupter chamber, causing the interrupter contacts to open. Passing axially along the arc path the air-blast transfers the arc to the arcing contacts and then to the cooler chamber, where the arc products are expanded, cooled and exhausted. Simultaneously, air is fed to the opening cylinder of the isolator drive and the opening of the isolator blade takes place after the interrupter arc is extinguished and while the interrupter moving contacts are open. The energising of the electro-pneumatic "closing" valve causes air to be admitted to the closing cylinder of the isolator operating drive to operate the isolator blade, a spring bias device assisting the closing motion. As the circuit breaker closes, an auxiliary contact, operated by the isolator drive, opens and de-energises the closing valve, the air supply being cut off as the blade comes to rest in full contact.

An example of specialised utilisation is the air-operated electric rivet-heating and upsetting machine exhibited by Holden and Hunt, Ltd., and shown in one of our illustrations. This particular machine has been specially developed by the company for the heating and closing of rivets for specific jobs, such as the differential crown wheel on the Ferguson tractor. Rivets from $\frac{1}{8}$in to 1in diameter can be handled and the transformer ratings can be varied from 50kVA to 350kVA. By a slight modification to the tooling the machine can be converted into a projection welder.

The electric motors shown include a totally-enclosed induction motor of 250 h.p. and 970 r.p.m., complete with control cubicle and a push-button control pedestal, supplied by Metropolitan-Vickers Electrical Company, Ltd., and a totally-enclosed, fan-cooled squirrel-cage induction motor produced by Bruce Peebles and Co., Ltd. This three-phase, 50 c/s, 400V motor develops 20 b.h.p. at 975 r.p.m. and is suitable for operating in conditions requiring protection from dust, dirt, fumes and dripping water.

An interesting exhibit is the "Cintel" industrial electronic metal detector, which is a product of Cinema and Television,

ELECTRONIC METAL DETECTOR

Ltd. This automatic inspection device detects the presence of any metal, ferrous or non-ferrous, in any non-metallic material and consists of a search-head and a control unit. The head is constructed to suit the size of the product, which is passed through a central aperture on a conveyor belt and consists of a former on which three coils are wound—an oscillator coil and two pick-up coils. This coil system is

HEAT PUMP INSTALLATION AT THE SOUTH BANK

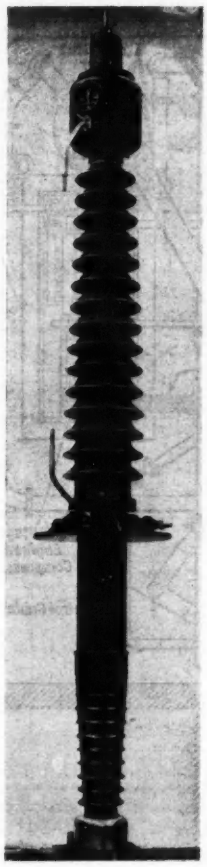
HEAT PUMP EVAPORATOR

CONTROL DESK

ENGINES AND COMPRESSORS

CONDENSER, FILTER, VALVES, ECONOMISER AND SEPARATOR

suspended in an all-metal casing and so connected that the mutual inductance between the oscillator and pick-up coils is zero. Any metal entering the search field disturbs this state of electrical balance and the minute voltage induced in the pick-up coils is fed back to the control unit, where it is amplified and then used to operate a relay. This relay controls an alarm system, which gives warning by means of various systems. The control unit consists of a main amplifier and detector, stabilising



275KV TERMINAL BUSHING

transformers, main switch and relay unit. The amplifier contains valves and components mounted on a cadmium-plated steel chassis fitted inside a dust-proof casing; anti-vibration mountings guard the circuits against outside blows. Our illustration (p857), shows the search-head in operation and the control unit mounted alongside.

The exit from the Hall of Electricity is flanked by two 275kV terminal bushings and stands, one supplied by The Bushing Company, Ltd., and the other, which we illustrate, by Micanite and Insulators Company, Ltd. In this terminal the main insulation is provided by an interior condenser bushing of paper impregnated with oil, which is totally immersed in oil and is enclosed in a ribbed porcelain insulator at the oil end, a metal flange in the middle and a shedded porcelain insulator at the outdoor end. There is ample room for oil expansion and the parts are held together through a spring by a brass tube, which carries the interior condenser bushing. The electrical connection to the top terminal is made through a flexible connector inside the top cap and the bushing is sealed hermetically against oil leakage or water ingress.

(To be continued)

The Heat Pump at the South Bank

As part of an extensive research programme into the economic and efficient use of fuel which is being carried out by the Ministry of Fuel and Power, an interesting heat pump has been installed in Arches under Hungerford Bridge, at the South Bank Festival Site, and is being used to provide heat for the Royal Festival Hall. The use of this kind of plant is, of course, not new, and our readers will remember the interesting pump at Norwich, which was described in our issue of August 31, 1945. The new heat pump, believed to be the largest in the world, is used in conjunction with a gas boiler heating system in the Hall. It is purely experimental and with such a full-scale plant in service its actual performance can be studied and comprehensive data obtained, which would not normally be acquired when operating a prototype unit under laboratory conditions.

The design, development and installation of the plant has been made under the supervision of Mr. P. Montagnon, a member of the staff of Dr. Roxbee Cox, Chief Scientist at the Ministry of Fuel and Power. This department also financed the project, in the construction and development of which three main contracting firms co-operated.

The plant has been designed to supply up to 9 million B.Th.U. per hour to the Hall system, and it is estimated that on full rating it will have a gas consumption of about half that of comparable gas boilers. Another feature of the plant that is of particular economic importance is that it can readily be adapted by changing the flow through the system to supply cooled water to the Hall in summer. This cooling would otherwise entail the installation of a large refrigerating plant which would probably only be used for a few weeks each year.

In the initial stages of the project it was decided to use light, compact, high-speed equipment for driving the heat pumps. Accordingly two Rolls-Royce "Merlin" engines were converted to use town's gas as fuel, the supercharger units of the engines being rebuilt and used for first and second-stage compressors. In addition to a condenser, an evaporator and other ancillary equipment, a comprehensive range of control and recording equipment is installed in a sound-insulated cabin at one corner of the plant. The lay-out of the pump, its engines and other equipment can be seen in the drawings and photographs we reproduce.

The principle upon which the heat pump works, as is generally known, is a use of the refrigeration cycle, whereby heat at a low temperature is extracted from a readily available source and finally transferred to another medium at a higher temperature level. In the case of the South Bank pump, the low-temperature source of heat is water from the River Thames and, through the medium of the plant, the water in the Festival Hall system is heated. The working fluid used in the pump system is "Freon 12," which boils at $-21{\cdot}7$ deg. Fah. at atmospheric pressure.

Centrifugal compressors, such as are used in the plant, have characteristics very different from reciprocating compressors or any positive displacement type of compressor. At a given speed there is a maximum flow which can be pushed through the compressor and in this condition the unit is "choked" and no pressure rise occurs across the compressor. As the mass flow is reduced the pressure ratio rises, as also does the isentropic efficiency until a fairly flat peak is reached where the pressure ratio is the highest obtainable at that speed and the efficiency is also at or about its maximum. An attempt to reduce the mass flow still further results generally in a slight loss of pressure ratio until suddenly a "surge" occurs which is no more than a violent fluctuation of pressure in the whole system; such a fluctuation can, however, be sufficiently strong to shake the whole plant.

It will be appreciated that for a given mass flow of refrigerant round a system of this kind the liquid must be boiled at the appropriate rate in the evaporator. With a given flow of river water through the evaporator tubes, this entails a definite temperature difference between the water and the refrigerant, but at this precise temperature the refrigerant has a definite pressure which has to be the pressure at the inlet to the first of the two compressors used in the plant.

A similar state of affairs obtains in the condenser, where, in order to condense the refrigerant at a specified rate, there has to be a definite temperature difference between the water from the Concert Hall and the condensing temperature of the refrigerant. This determines the refrigerant pressure at the outlet from the second compressor of the plant.

The overall pressure ratio of the system is thus determined by outside conditions and the rate at which the refrigerant is circulating round the system. There is only one speed at which a matching pressure ratio and rate of flow can occur in the system with both the compressors working at high efficiency. There is also an appreciable operating range of mass flows at a given speed for each compressor without a material drop in efficiency, so that it is not necessary to run the plant with the compressors running at a precise speed.

An increase in compressor speed has the effect of increasing the maximum pressure ratio obtainable as well as the rate of flow through the compressor at the "surge," the peak efficiency, and the "choked" positions. Similarly, a reduction in speed reduces the mass flow and the pressure ratio obtainable.

It follows from this that a pressure ratio between evaporator and condenser, determined by outside conditions, cannot be achieved with less than a certain rate of flow of refrigerant, because the pressure ratio demands a certain compressor speed, and at this speed there is a minimum acceptable rate of flow.

This means that in warm weather, when the river is probably warmer than usual, and the Concert Hall water does not have to be very hot to provide the necessary heat, the plant is unable to supply a small enough amount of heat because the heat output of the plant is basically determined by the latent heat of the refrigerant being condensed. To overcome this difficulty, a by-pass line, which short circuits the condenser and the evaporator, is used so that the mass flow of refrigerant can be kept up through the compressors without it all having to be condensed and evaporated again in the rest of the system.

It will be seen from the diagram of the circuits on page 861 that water from the Thames is pumped through an evaporator where its heat is used to convert "Freon" liquid into low-pressure vapour. This vapour is then passed through the first and second-stage compressors where its pressure is raised with a proportionate increase in temperature. From the second-stage compressor the vapour passes first through an oil separator and then into the tubes of the condenser, which are surrounded by water from the Hall circulating system. As the vapour is condensed, the latent heat of condensation is abstracted from it at its relatively high temperature, and transferred to the heating system water. The "Freon," now restored to its liquid condition, leaves the condenser at a high pressure, and after passing through a filter has its pressure reduced in two automatic float valves. The second of these valves is combined with a gas separator, known as an "economiser," in which the flash gas produced in the first valve is removed and piped back to the second-stage compressor. This arrangement effects an economy in that the passage of the amount of vapour recovered into the evaporator and through the first-stage compressor is avoided.

The water from the Festival Hall system is circulated round the condenser by a pump driven from the engine of the first-stage com-

pressor. After this water leaves the condenser, it passes through a waste heat boiler, where its temperature is increased by the hot exhaust gases from the engines. The main pipe carrying the Hall water from the condenser to the waste heat boiler is tapped to supply water to the coolers for the engines and lubricating oil. When the plant was being designed, it seemed likely that under certain operating conditions this water would be too hot for cooling purposes, and another line was introduced to enable cooling water to be obtained from the main flow before it entered the condenser.

Hot water from the heat pump is fed into gas-fired, hot-water boilers situated in the Festival Hall and passes through them into the heating system. These boilers are controlled by thermostats in the Hall, and in cold weather, when the temperature required in the water is beyond the capacity of the heat pump, the boilers are automatically brought into service to raise the temperature to the necessary level.

As already mentioned, the heat pump is also designed to cool the water in the Festival Hall system in summer, and in hot weather the river water is passed through the condenser and the Hall water through the evaporator, thus "reversing" the heating cycle. In warm weather, when the full capacity of the plant is not required, the second-stage engine and compressor are not used, and the first-stage units only are connected to the condenser.

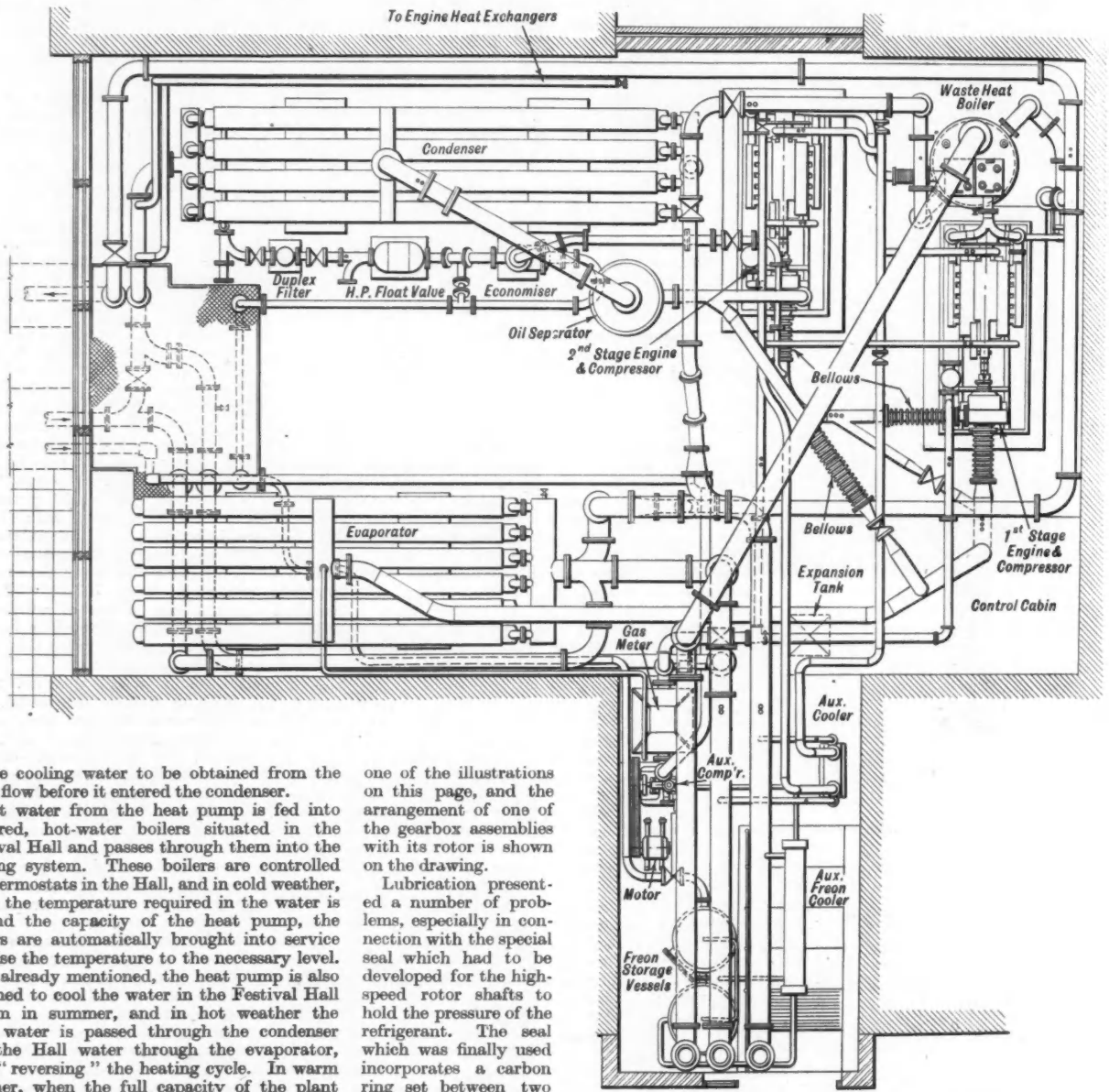
The Rolls-Royce "Merlin" Mark 140 engines used for the plant were selected as the most suitable units as their gear ratios were very close to those required for the projected conversion, and a number of other parts could be used. The compression ratio of the engines has been increased to suit them for operation with town's gas. Three standard gas carburetters are fitted to each engine and they now develop some 350 h.p. A disc flywheel with a toothed rim on the propeller shaft is coupled to an electric motor for engine starting purposes. The compressors, which were partly constructed from redesigned elements from the original superchargers fitted on the engines, are driven from the power take-offs of the engines through gearboxes, giving a 7 to 1 compressor engine speed ratio. The gearboxes used are the original engine units modified and rebuilt to comply with the new requirements, and they are coupled to the engines through Hardy Spicer couplings. In the construction of the compressors, a number of the supercharger units, including the rotor shafts, bearings and impellers, were used. To suit the new working conditions for the compressors, the supercharger impellers and rotating guide vanes were reshaped, whilst new diffuser blades and casings were developed. The two engines, with their compressors and connections, can be seen in one of the illustrations on this page, and the arrangement of one of the gearbox assemblies with its rotor is shown on the drawing.

Lubrication presented a number of problems, especially in connection with the special seal which had to be developed for the high-speed rotor shafts to hold the pressure of the refrigerant. The seal which was finally used incorporates a carbon ring set between two lapped metal faces. The seals are submerged in oil flowing through the housing under a pressure slightly in excess of the external refrigerant pressure. Any oil seeping past a seal is collected by a flinger ring on the shaft. The return flow of oil from the seals is collected and passed through a separator on which any refrigerant is recovered and returned to the system.

The main rotor bearings are also pressure-oil lubricated and the oil swept away by the refrigerant vapour is recovered in an oil separator before the refrigerant passes into the condenser.

The engine used for the first compressor stage is coupled through a belt to a pump used for circulating the water of the Hall hot water feed system. A small belt-driven pump at the front of each engine is used to circulate the water which is drawn from the condenser cooling water system through the lubricating oil coolers.

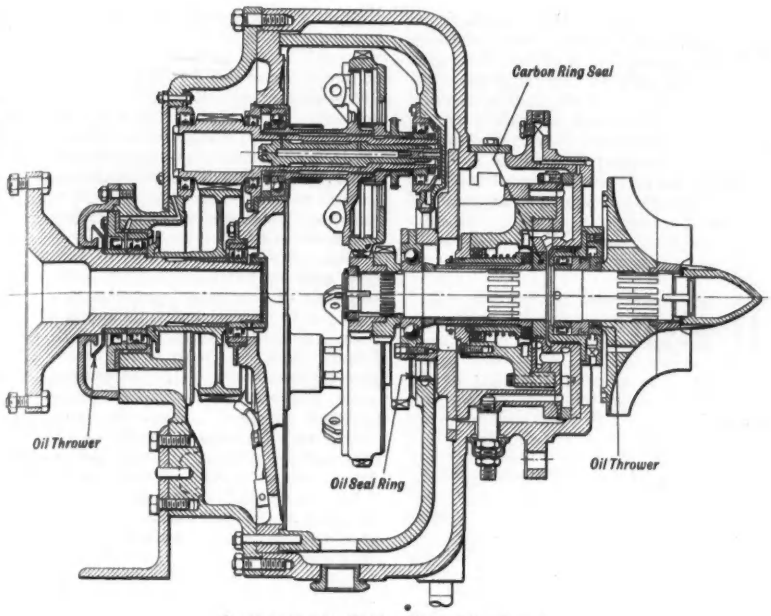
Owing to the experimental nature of the plant, it will be necessary to dismantle various sections from time to time for inspection, and for this reason tanks have been installed into which the refrigerant can be pumped and stored while work proceeds. Electric motor-driven pumps and auxiliary equipment have been provided to draw the refrigerant out of the circulating system of the heat pump on these occasions and return it when required.



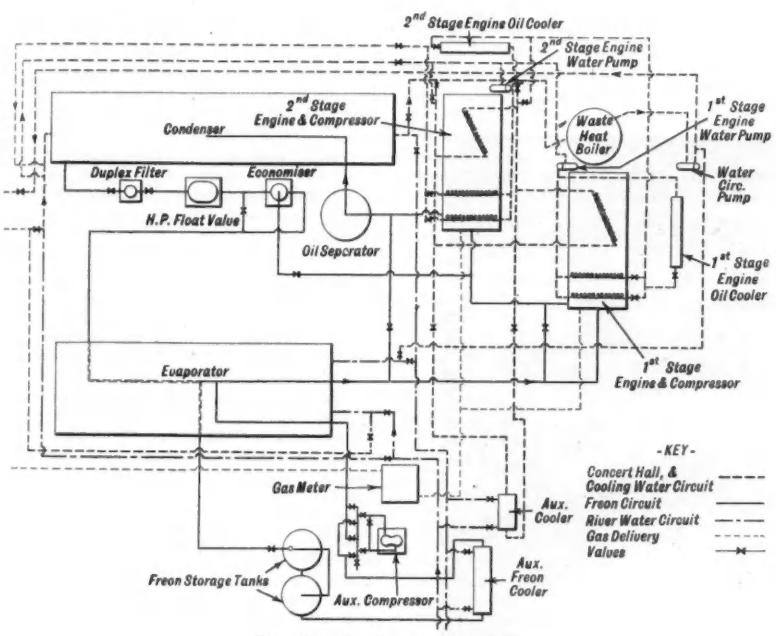
GENERAL ARRANGEMENT OF PLANT

It will be appreciated that with a large prototype pump of this kind, but little operational data were available on much of the newly designed equipment. For this reason, extensive trials were carried out on each major unit as it was completed, and after testing it was fully calibrated before being installed or coupled up to associated units.

As we have already mentioned, the plant is controlled from a small room which is built in one corner opposite the engines and compressors which can be clearly seen through a large window. Immediately below the corner is the control desk shown in one of our illustrations. In addition to the engine control levers, a series of indicator lamps on this desk show if the lubricating systems, &c., are functioning correctly. All of the controls for the pumps



COMPRESSOR GEAR BOX ASSEMBLY



PIPING AND VALVE DIAGRAM

are manually operated at present, but a comprehensive scheme is envisaged for the installation of full automatic control of the plant. With the recorders and other instruments which have been installed, the control room is fully equipped to provide detailed records of the functioning of all parts of the pump.

During the next few months much valuable information will be obtained from this interesting plant, working under different conditions, and although it has, as yet, been operated for relatively short periods, we understand that the results obtained to date indicate that it will prove to be fully capable of the duties for which it has been designed and built.

In the construction of the plant Alan Muntz and Co., Ltd., North Hyde Lane, Heston Airport, Hounslow, Middlesex, was responsible for the development and adaptation of the engines, gearboxes and compressors; Matthew Hall and Co., Ltd., 26–28, Dorset Square London, N.W.1, carried out the pipework, plant lay-out and general installation, and the U.D. Engineering Company, Ltd., Cumberland Avenue, London, N.W.10, supplied the evaporator, condenser and refrigerant control gear.

Naval Gas Turbine Developments

RECENTLY we were able to make a trial run in the harbour launch H.L. "3964," which is the Royal Navy's first craft to rely entirely upon gas turbine power. As already mentioned in our issue of June 15th, the power unit was built by the Rover Company, Ltd., and it has already seen service in the "Torquil," which was described in THE ENGINEER on October 20th, 1950. The engine was taken out of the "Torquil" and modified, before installing it in the launch, by arranging for only one combustion chamber to be used and so improving efficiency. There is ample space in the engine-room and a noticeable lack of vibration when the engine is running. Starting is by 24V battery, and all controls, which are electric, are from the small wheelhouse. A 7 : 1 reduction gear is housed integrally with the engine and the final drive is through a gearbox, manufactured by the Self Changing Gear Company, Ltd., which makes the overall reduction 21 : 1. In the engine-room is a small Crossley diesel engine which drives a generator for charging the batteries, a bilge pump which also can be used for circulating cooling salt water to the oil tank and gearbox, and an oil pump which supplies oil to the gearbox when it is in neutral, because the oil pump in the gearbox stops when it is not transmitting power. While the service trials are proceeding, the Rover Company, Ltd., will be engaged in developing a heat exchanger with which to effect a reduction in fuel consumption, which is at present at a high level.

On the same day we visited M.T.B. "5559," which was formerly M.G.B. "2009," and as such was the first craft to go to sea (1947) with a gas turbine installation. The Metropolitan-Vickers 2500 h.p. gas turbine was coupled to the centre shaft in place of a 1300 h.p. Packard engine and used as a boost power unit so that the high fuel consumption was only of secondary importance.

It is recognised by the Admiralty that it is essential to be able to burn residual grades of fuel in gas turbines and to that end a Gatric gas turbine similar to that on board M.T.B. "5559" has been undergoing bench tests burning boiler fuel, to Admiralty specification, and also a fuel of high sulphur content. The first Gatric turbine after removal from the boat, was rebuilt and included modifications which mainly concerned the section of the h.p. turbine blading and allowed the maximum output of 2500 s.h.p. to be attained. This engine was used in the tests, which were carried out without any modification being made, as the object was to discover if an engine designed to work on distillation fuel could burn heavy fuel.

The "A" test series consisted of seven-hour-cycle tests on gas oil/boiler fuel blends containing successively 20, 40, 60, 80 per cent boiler fuel and then 100 per cent boiler fuel. The cycle was made up of six hours at maximum cruising revolutions and short periods under partial load, full load and idling. After the boiler fuel test, carbon was found in the combustion chamber, the deposit being heaviest on the back plate, while there was a flaky carbon build-up, easily peeled off, on the first stage fixed and moving blades of the h.p. turbine. The results indicated that the engine was not suited to heavy fuel except for a run of limited period and that carbon build-up was heavy at idling and low powers.

In "B" tests high sulphur fuel (2·78 per cent), with a viscosity similar to gas oil, was used over a period of fifty hours. Inspection indicated red and yellow deposits in some places and buckling of the inner wall of the primary chamber, besides corrosion of the fuel jet shields. These were of Inconel, and it appears that where the nickel content of the steel is high there is danger of sulphur attack. After repairs were effected, carbon formation tests "C" were carried out, in which the engine was started on gas oil and run for one hour on boiler fuel at a constant speed. Through an inspection cover it was observed that there was no deposit at high speeds but an increasing amount as the speed was reduced down to 4000 r.p.m. A run at 7000 r.p.m. on gas oil served to burn off most of the carbon. A further test at idling speed was terminated after twenty minutes when the compressor stalled due to the partial blocking of the h.p. turbine blade passages.

In "D" tests air blast fuel jets were used to burn boiler fuel in the engine. The jets were designed to give good atomisation over a range of fuel flow and a spray within a 40 deg. cone angle, oil being fed from a small swirl chamber through a central orifice. Around the orifice is an annulus through which air is fed. Maximum excess of air pressure to fuel jets over combustion chamber pressure was 10 lb per square inch and the air flow varied from 0·25 per cent of air to engine inlet at 7000 r.p.m. to 0·4 per cent at 3000 r.p.m. The jets showed no improvement over standard jets in the matter of carbon deposit, but the exhaust at low speed was improved.

In the final test ("E") the engine was run for forty-eight hours on boiler fuel and after observations were taken at high loads the revolutions were kept constant at 6850 r.p.m. Inspection revealed quantities of carbon in

the combustion chamber but little elsewhere, and only slight damage to components except for the corrosive attack upon the fuel jet shields. The blading was in good condition but several of the dual fuel jets were carboned up and the gear pump bearing material proved unsuitable for handling fuel heated to 120 deg. Cent.

The tests on the Gatric engine, which were carried out by the Metropolitan-Vickers Electrical Company, Ltd., two years ago, showed that although practically all the constructional materials stood up to heavy fuel, the combustion system was not suited to it and that the engine was less adversely affected than anticipated.

Work is proceeding with the development of gas turbines and this design of engine will be installed at an early date in two fast patrol craft, and in the larger power range one unit has been designed for installation in a frigate and another for the former steam gunboat "Grey Goose."

Rolling Mill Design

No. I

MECHANICAL engineering features of four modern steel rolling mills were discussed at a conference organised in London on June 13th and 14th by the Plant Engineering Division of the British Iron and Steel Research Association. Mr. J. F. R. Jones, consulting rolling mill engineer to John Summers and Sons, Ltd., was in the chair. Four papers describing different rolling mills were introduced and discussed. They were:

"The New 42in Slabbing Mill at Shotton," by J. F. R. Jones; "New Blooming and Billet Mills at the Normanby Park Steel Works of John Lysaght's Scunthorpe Works, Ltd.", by J. Peacock; "A Rod and Bar Mill at Guest, Keen and Nettlefolds (South Wales) Ltd.", by G. A. Phipps; and "The Light Section Mill of the Darlington and Simpson Rolling Mills Company, Ltd.", by W. French.

Summaries of the papers and of the main lines of discussion follow.

STEAM ENGINE DRIVE FOR 42IN SLABBING MILL

THE 42IN SLABBING MILL AT SHOTTON

This mill, which replaced an American-designed 40in mill installed in 1940, rolls slabs up to 54in wide, the full width of the hot strip mill which it feeds. It has been in operation since August, 1950, and took only twenty-eight days to install, attaining full production a week after installation was completed. The mill was put down on existing foundations, on which the previous mill had operated. It was also decided that it be driven from the existing three-cylinder horizontal steam engine. Roll housings are of the closed top type, with minimum cross sectional post areas of 500 square inches, specially designed to accommodate the necessary maximum lift on the top roll of 61in. There is a breast and first roller at each side of the mill. Housings are lined on the insides of the windows with steel wearing plates for the sides of the top chocks and the sides and bottoms of the bottom chocks. The housings are carried on continuous heavy box section bed-plates seated on the existing foundations.

Cast steel chocks are used and are fitted with flood oil-lubricated bearings for the roll necks. The two bottom chocks are mounted on a heavy cast steel sledge, the withdrawal of which on to the fabricated runout brings with it both rolls and chocks in the one operation. Rolls are changed about every three weeks, the operation taking some four hours.

Screwdown gear for the 61in lift is supplied with a twin-motor electric drive from two 150 h.p. motors which give a screwing speed of 250in per minute. In addition to the moving finger dial indicator, two indicators are mounted on the end of each screw which register fine settings down to $\frac{1}{16}$in; these indicators are illuminated and made visible to the mill operators.

Top roll balance is provided hydraulically from two cylinders carried in the housing tops and having 12in diameter, Fescolized, cast iron rams made for an hydraulically working pressure of 700 to 750 lb per sq. in. The ram of each cylinder is connected by crosshead, levers and links to two balance beams running across between the housings and secured to the top rider chocks, the balancing effort being transmitted to the carrier chocks by special bolts which are removed when roll changing.

The steam engine drive, as illustrated, is provided by a three-cylinder horizontal steam engine with a nominal horsepower of 4000 at 55 r.p.m., and a maximum horsepower of 5300 at 105 r.p.m. "Though it has a number of years of hard service behind it (it was built in 1917)", said Mr Jones, "this engine's performance under its particularly exacting duty is quite first class, providing a reserve of power adequate for all the new mill's needs, with positive and instantaneous reversals which the most modern electric drive would find hard to match." The gear ratio on the original mill was approximately $2\frac{1}{4}$ to 1, which has been increased to 3 to 1.

The drive is transmitted to the reduction gear unit by flexible coupling, while a further coupling of the same type connects the gear box to the new pinion housing which has been supplied with the mill, and which is totally enclosed with spray lubrication to the pinion teeth. Initial gearing troubles were overcome very successfully by hand-bedding all gears. From the pinion housing the drive is transmitted to the mill by coupling spindles provided with couplings of the universal jaw end type arranged for lubrication from the central system at the pinion housing end and at the mill end for grease gun lubrication by means of Tecalemit nipples feeding a storage chamber.

Hydraulic balance is provided for both top and bottom spindles by the same hydraulic system as provides for the top roll balance gear with suitable isolating valves to hold the spindles in position during roll changing.

The manipulator hands are 25ft 6in long overall, and are fitted with separate cast steel wearing faces. Each is motivated from a pair of slab rams with underneath racks operated by pinions carried on long shafts and driven by electric motors through a double reduction gear unit. The side-guard travel is 7ft $7\frac{1}{2}$in, while provision is also made for 2ft 3in over travel on the drive side heads to allow for the removal of rollers in the main mill tables. The heads on the ingoing side have a general depth of 4ft.

Both heads on the ingoing side are connected through pinion shafts to the corresponding heads on the outgoing side of the mill, so that the opposing heads are always in exactly corresponding positions and the slab leaves the rolls perfectly straight. The slab rams themselves are guided in phosphor bronze liners which are fixed in the roller table frames.

The tilting gear is an interesting feature and is somewhat novel. The motion on the tilting finger shaft is transmitted via a pair of toothed quadrants, one keyed to the shaft and the other receiving its motion in turn from a long connecting-rod arranged, to overcome lateral space shortage, approximately parallel to the tilting finger shaft itself. A 100 h.p. motor drives through a reduction gearbox and crank mechanism connected to the main long connecting-rod by a shorter connecting-rod and bell-crank lever. The bell-crank lever is anchored at a fixed fulcrum point on a rectangular block arranged to slide in a fixed housing. This floating arrangement is specifically designed to accommodate the lateral movement of the tilting head during racking operations. A further important feature of this tilting mechanism is that the driving elements are fixed on foundations, thus eliminating any necessity for trailing cables, and reducing the weight of the moving parts to a minimum.

The parallel heads on the outgoing side of the mill are not fitted with tilting equipment. The first and breast rollers on both sides of the mill are driven by independent motors through flexible couplings and independent gearboxes. The breast rollers proper are loose on their shafts. Existing main roller table frames were retained but new rollers were fitted with stepped diameters to match the mill rolls. This results in a minimum of noise and shock when the piece enters and leaves the mill.

Roll cooling is by sprays from a water box carried between the two balance beams for the top roll; mill screws are oil lubricated from the central system; chock slide, spindle bearing and breast roller lubrication is effected by a "Farval" automatic system operated by pump and motor; scale disposal is effected by hydraulic sluicing under the tables and by scraper conveyors under the mill.

The mill is operated by a three-man crew

housed in a control cabin above and athwart the mill approach table.

Slabbing Shears

From the mill the long slabs travel down the continuous roller table to the open-sided up-cutting hydraulic slab shear which forms the other major unit of this new mill installation.

This shear, the original design of which is due to Mr. W. H. Lake, is capable of cutting slabs 55in wide by 5in thick or equivalent section up to a maximum thickness of 8in. It has a maximum blade load of 900 tons with a maximum stroke of 12in. The blades are 60in long. Having a main ram diameter of 25in and employing a working pressure of up to 2 tons per square inch, the shear is capable of making three cuts per minute continuously. This machine too, was designed to fit on to previous foundations.

The main element of the shear is a C-shaped steel casting weighing 70 tons bored at the top to receive the forged steel hydraulic main cylinder, with the bottom part forming the holder for the bottom cutting blade. This casting also has machined guides embracing the top blade holder, which is adjustable by motorised gear in the back of the shear to position the blade opening according to the thickness of the slab to be cut.

There are two electrically-driven crop end pushers, operated through racks, pinions and guides carried in the lower shearing head. There is automatic hold-down gear and "Farval" automatic grease systems lubricate the main shearing head slides, the guide blocks pushers and setting gear.

Discussion

In the discussion on this paper the steam drive came in for much comment. Mr. W. Bailey (Davy and United Engineering Company, Ltd.) questioned the wisdom of retaining it. His experience had been that conversion to electric motors had usually repaid the capital cost inside three years.

Mr. R. Stewartson (United Steel Companies, Ltd.) quoted some production figures from two American mills. One with an electric drive using similar size ingots to those at Shotton and reducing them to slabs and blooms was averaging 1280 tons per shift and had achieved a record production when rolling slabs alone of 2063 tons per shift. Another mill at Weirton, with a 25,000 h.p. steam engine was turning out 2000 tons per shift of slabs and blooms.

Mr. H. S. Carnegie (English Electric Company, Ltd.) said that the steam engine appeared to be giving satisfactory service, but was it able to give enough draught on the slabs? The engine power seemed low, whilst the fuel consumption, operating labour, maintenance and cost of stores would probably be higher than with an electric drive.

Mr. B. Thornton (Wellman Smith Owen Engineering Corporation, Ltd.) thought there was much to be said for the flexibility of a steam engine. But would it be retained if the mill began to roll 19-ton ingots with an increased tonnage? Would it not be necessary to increase the drive with the increasing tonnage? And would it not be then necessary to use a greater horsepower than the steam engine could provide? He thought that the reversal on a steam engine was "sweet," but he would like figures on the question whether it was quicker than a modern electric motor.

Mr. Jones replied that they had decided to use the steam engine because it was already installed there; that the exhaust steam was used in a mixed pressure turbine and the consumption of steam per ton rolled was about 500 lb. The mill was at present working about 60 per cent of the available time and was turning out 10,000 tons per week. He was quite confident that they would work 20 shifts if necessary and this was the answer to those who asked how they could get the extra tonnage without increasing drive.

Many of the comments on topics raised in this paper were spread over discussions on the other papers and in the general discussion, but for convenience are summarised here.

A subject that drew comment was the hand bedding of gears. Several speakers said it was an expensive practice, and both Mr. W. Craig (Davy and United Engineering Company, Ltd.) and Mr. G. A. Phipps (Guest, Keen and Nettlefolds (South Wales) Ltd.) thought it should not be necessary if the gears had been properly machined in the first place. Mr. R. Stewartson, however, agreed with Mr. Jones that it was worth while quoting his own previous experience in the works of a turbine manufacturer, which had shown this to be the case for high speed drives, while Mr. P. M Miln (Richard Johnson and Nephew, Ltd.) drew on a similar experience in the mill at his works.

Mr. Stewartson also raised the question of screwdown speeds. American practice was around 420in per min., although some mills claimed to operate at 600in per min. Mr. W. H. North (Richard Thomas and Baldwins, Ltd.) did not see the point of this. Such speed was only wanted when the slab was being tilted, and then there was time to use a slower speed. The need was rather for quick acceleration over short movements.

Mr. Stewartson said that though the slab was certainly tilted slowly, during the several edging passes, the slab was then dropped on to the tables very quickly, leaving the screwdown to follow as fast as possible. Mr. Jones said that his mill had never had to wait for screwdown.

The use of flexible couplings on the mill drives in addition to the resilience of steam provoked some discussion, and Mr. Jones repeated that he thought them desirable.

Mr. T. W. Hood (United Steel Companies, Ltd.) raised the question of roll balance. The conventional method of roll balance was a hydraulic one, but consideration should be given to other systems such as a spring balance and a weight balance. Mr. Thornton, too, queried the necessary advantage of a hydraulic system of roll balance. Hydraulic operation would consume more power and maintenance effort than a weight balance system.

Mr. W. Udall (Brightside Foundry and Engineering Company, Ltd.) thought that the hydraulic method was not necessarily the best. A spring balance method was now favoured by his firm, in which once the springs were compressed they need never be de-compressed.

Mr. Jones said that using water plus soluble oil they had very little maintenance or power cost.

Mr. S. Dean (British Iron and Steel Research Association) related screwdown speed to overbalance of rolls.

Might it not be possible to cut down the 50 per cent overbalance which was common?

Breast roller drives were also discussed. Several speakers said that they liked a positive drive, and Mr. Jones agreed that a low speed motor on each breast roller would be ideal but they simply had not the space to install it at Shotton. Mr. H. S. Carnegie agreed that this was the best method. Low speed motor drives without gears gave minimum inertia in the drive and maximum simplicity. Mr. W. Udall, however, said that such motors did not last in rolling mill conditions. He preferred a "reasonably high speed motor with reasonable gearing and a slipping coupling which could be only adjusted by the use of a special tool."

(To be continued)

Kirk O'Shotts Television Transmitting Station

The television transmitting station now being built at Kirk O'Shotts will be the third high-power station to be completed under the B.B.C.'s post-war plan for the expansion of television coverage. When it is in service more than 70 per cent of the population will have been brought within reach of television. With the completion of the fourth new station at Wenvoe next year this figure will be increased to 78 per cent.

Construction at Kirk O'Shotts began last year, and it is hoped that the station will be ready to start broadcasting television programmes early in 1952. The site is 900ft above sea level about 17 miles from Glasgow on the Edinburgh-Glasgow road. It is one of many sites which were investigated by setting up at each a mobile transmitter which radiated test signals from an aerial suspended by a balloon 600ft above the ground. The strength of the signals received from it was recorded, using a van in which a continuous recording could be taken as the surrounding countryside was toured. From these records field-strength contour maps were prepared showing the probable service area that would be obtained with a high-power transmitter at each site, so that the merits of each could be compared.

The site covers an area of about 25 acres, and on it are being constructed a building for the transmitters, an annexe for a substation and garage, and a 750ft mast to carry the transmitting aerial. In plan the main building is similar to those at the Sutton Coldfield and Holme Moss stations, being shaped like an L. One wing is for the transmitters and their associated equipment, while the other will be for offices, a viewing room and amenities for the staff. The building contractors are McLean and Co., of Wishaw, Lanarkshire.

In the main building there will be two transmitters, one for vision and one for sound, designed and manufactured by Electric and Musical Industries, Ltd., and by Standard Telephones and Cables, Ltd., respectively. The vision transmitter, with a power output of 50kW, will be the most powerful television transmitter in the world. Its valves will be air-cooled, except for those in the output stage, which will be water-cooled, and it will employ low-power modulation. In addition, low-power transmitters for both sound and vision are to be installed as a standby. The vision transmitter will operate on a carrier frequency of 56·75 Mc/s (5·3m) and the sound transmitter on 53·25 Mc/s (5·6m). The electricity supply for the station will be from the British Electricity Authority. Two independent supplies are being installed, so that, in the event of an interruption on one, the station will still be able to carry on.

About 25 yards from the main building is the mast for the transmitting aerial. This mast, when completed, will be 750ft high and will have an all-up weight of over 100 tons. For the first 610ft above the ground the cross section is triangular, each face being 9ft wide; above this there will be a cylindrical section, 100ft high and 6½ft in diameter; and finally a tapering square-section topmast, 40ft high, to which will be fixed the transmitting aerial. In the surface of the cylindrical section there are to be thirty-two slots forming a v.h.f. (very high-frequency) aerial system designed by the B.B.C. for use with a v.h.f. transmitter for sound broadcasting if this is installed at Kirk O'Shotts in the future. The mast is held vertical by four sets of stays of prestressed steel wire rope, some of which weigh as much as 9 lb per foot run. In the main, the mast is similar to those at the Sutton Coldfield and Holme Moss stations. Following the usual practice, the base is located by a small steel ball mounted in a socket, forming a pivot which allows the mast some angular movement in high winds. The mast was designed and is being erected by British Insulated Callender's Construction Company, Ltd.

The transmitting aerial from which both the vision and sound components of the television programme will be radiated has been designed in co-operation with the B.B.C. by Marconi's Wireless Telegraph Company, Ltd., who will erect it. It will consist of eight vertical dipoles arranged in two tiers, each dipole having a built-in electric heater to prevent the surfaces from being covered by ice or snow. There will also be a smaller mast, 150ft high, with a simpler aerial to serve as a standby.

The Kirk O'Shotts station will broadcast the same programme as Alexandra Palace. The vision signals will come from London via Birmingham and Manchester, and thence by the radio link which the G.P.O. is installing.

The expected area for reliable reception will be bounded by a line through Wemys Bay, Aberfoyle, Aberfeldy, Kirriemuir, and Arbroath in the north, and through Turnberry Point, Old Cumnock, Selkirk, Melrose, and Cockburnspath in the south. This area has a population of 3½ million.

Metallurgical Topics

Vacuum-Melted High Chromium Steels

THE 23 per cent to 30 per cent chromium steel is ferritic: it cannot be hardened nor can its grain size be refined by heat-treatment. Although it shows satisfactory elongation and reduction of area in the tensile test when its grain size is not excessively coarse, it is very subject to brittle fracture and has an Izod impact figure of less than 5ft lb, usually only 1ft lb or 2ft lb. The steel generally contained 0·1 per cent to 0·3 per cent of carbon and improvements to its impact value were sought by making additions to the normal composition. In particular, the addition of a small amount of nitrogen by the use of high-nitrogen ferrochromium in making the steels greatly reduced their tendency towards coarse grain size and so gave rise to improved ductility and impact value.

Through the extensive work of Dr. W. Rohn and of numerous investigators the technique of vacuum melting has been developed and its possibilities explored. In 1948 J. Hochmann[1] obtained a marked improvement in the toughness of 25 per cent chromium-iron by first melting Swedish iron and super-refined ferrochromium in a high-frequency induction furnace and then remelting the product in a vacuum at 1600 deg. Cent. for twenty minutes and cooling *in vacuo*. The specimens were forged at 800 deg. Cent. Tests before and after remelting were compared and the improvement in toughness which was found was attributed to the accompanying reduction in carbon, oxygen and nitrogen contents.

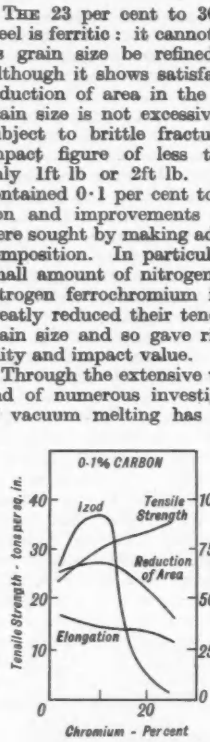


FIG. 1—*Typical Properties of Annealed Chromium Steels*

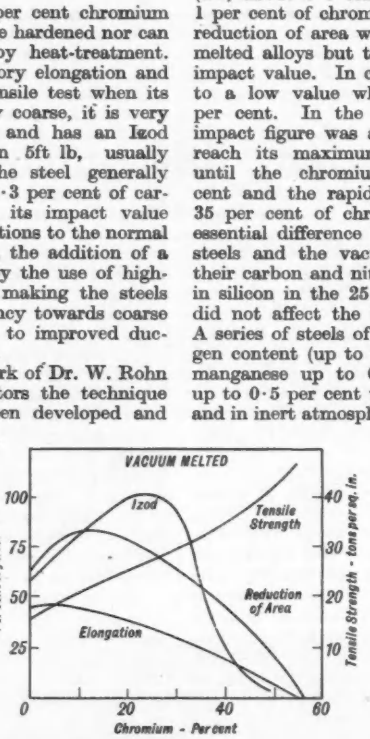


FIG. 2—*Mechanical Properties of Vacuum-Melted Annealed Chromium-Iron Alloys (Binder and Spendelow)*

Experiments in the vacuum melting of plain chromium steels have since been made by W. O. Binder and H. R. Spendelow, Jr.[2] The alloys investigated were made by melting *in vacuo* electrolytic chromium and iron, except that some 25 per cent chromium alloys were made from low-carbon ferrochromium and ingot iron. These contained 0·25 per cent of silicon: otherwise their composition resembled that of the other alloys, viz.:—

	Average per cent		Average per cent
Carbon ...	less than 0·01	Oxygen	0·04
Silicon ...	less than 0·02	Sulphur	0·016
Manganese	less than 0·02	Phosphorus ...	0·008
Nitrogen ...	less than 0·005		

Air-melted steels were made for comparison in a high-frequency induction furnace. The high-chromium alloys were heated for six hours at 900 deg. Cent. and water-quenched to avoid the formation of the sigma phase, FeCr. The others were annealed by heating for one hour at 900 deg. Cent., followed by three hours at 735 deg. Cent. Results of tensile and notched-bar impact tests are shown in Fig. 2. (For comparison, the approximate values of similar data for commercially produced chromium steels containing about 0·1 per cent carbon are given in Fig. 1.) The tensile strength of the vacuum-melted product was always lower than that of the air-melted steel of the same chromium content; but raising the percentage of chromium produced about the same increase in tensile strength (i.e., about 0·5 ton per square inch for each 1 per cent of chromium). The elongation and reduction of area were greater in the vacuum-melted alloys but the major difference was in impact value. In commercial steels this sinks to a low value when chromium exceeds 15 per cent. In the vacuum-melted steels the impact figure was always higher. It did not reach its maximum of 100ft lb to 110ft lb until the chromium content was 26 per cent and the rapid fall did not set in until 35 per cent of chromium was present. The essential difference between normal air-melted steels and the vacuum-melted alloys was in their carbon and nitrogen contents. Variation in silicon in the 25 per cent. chromium steels did not affect the notched-bar impact value. A series of steels of varying carbon and nitrogen content (up to 0·1 per cent of each) with manganese up to 0·75 per cent and silicon up to 0·5 per cent were made *in vacuo*, in air and in inert atmospheres. From tests on these, it was deduced that the 25 per cent chromium steel retained its highest impact value provided that the total carbon and nitrogen did not exceed 0·035 per cent, though normal air-melted steels containing upwards of 20 per cent chromium are improved in ductility and toughness through the addition of some 0·10 per cent to 0·25 per cent of nitrogen. The air melted 18 per cent chromium steel with 0·12 per cent (maximum) carbon has an impact figure of 15ft lb to 30ft lb, but the addition of nitrogen raises the impact value into the range 30ft lb to 50ft lb. The vacuum-melted 18 per cent chromium alloy, however, gave impact values of 80ft lb to 100ft lb, provided that the total carbon and nitrogen was less than 0·055 per cent.

The poor impact value of high-chromium steels appears to be due in some way to the carbon and nitrogen present: the chromium itself is not responsible. From Izod tests made at sub-zero temperatures it was found that chromium tends to lower the temperature of transition from tough to brittle fracture (Fig. 3). In the 12, 18 and 25 per cent chromium alloys the transition temperatures were respectively, −65, −90 and −130 deg. Cent.

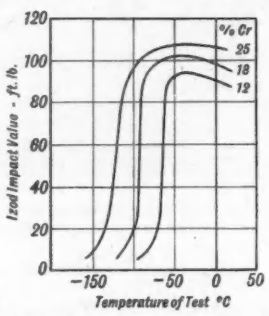


FIG. 3—*Effect of Chromium on the Transition Temperature of Vacuum-Melted Annealed Chromium-Iron Alloys (Binder and Spendelow)*

Numerous difficulties are encountered in the vacuum-melting of high-chromium alloys apart from the fact that the necessary plant is not available for dealing with large amounts. The room-temperature embrittlement is eliminated by Binder and Spendelow up to about 40 per cent chromium. To extend this range it seems likely that a further reduction in oxygen content, below the 0·04 per cent reported, will be necessary. Chromium metal purged of oxygen to the level of 0·015 per cent is still brittle at room temperatures[3]. No long-time purification is possible as the very low operating pressures result in the volatilisation of chromium. Binder and Spendelow employed twenty minutes at a pressure of 0·2mm to 0·3mm. The liquid reacts with oxygen and nitrogen very rapidly and the molten metal has, therefore, to be transferred to a mould and solidified without contact with air. In spite of the gain in toughness the mechanical properties may not meet requirements in other respects. The tensile strength of the vacuum-melted alloys is low and sigma-phase embrittlement will still affect alloys in the higher chromium range. These deficiencies may possibly be corrected by a suitable choice of additional alloying elements. In any event, the work of Binder and Spendelow has shown that a tougher material with superior workability can be obtained in the iron-chromium compositions which give the best resistance to corrosion and scaling at high temperatures.

[1] J. Hochmann: *Comptes Rendus*, June 28, 1948, vol. 226, page 2151.
[2] W. O. Binder and H. R. Spendelow, Jr., American Society for Metals, Annual Convention, October, 1950, Preprint No. 23.
[3] E. A. G. Liddiard and A. H. Sully, Iron and Steel Institute, Symposium on High-Temperature Steels and Alloys, February, 1951.

Protective Coating on Molybdenum

THE development of materials for high-temperature service is complicated by the fact that no one group has all the desirable properties. Ceramic materials, such as oxides, are attractive because of their chemical stability, but they are difficult to fabricate and for the most part have low resistance to mechanical and thermal shock. Metals of high melting point are often free from these objections, but are usually subject to oxidation, corrosion and scaling at high temperatures.

A great advance has been made during the last few years in the fabrication of molybdenum which, in many respects, has a promising field of high-temperature applications; but, because it is so readily oxidised at high temperatures, its surface must be protected. One method of doing this is by coating the surface with molybdenum silicide. Such a coating may be produced in a variety of ways, such as hot-dipping in molten silicon, flame-spraying powder, heating in a silicon pack, electrolysis of fused silicate baths at high temperature or fusion welding with molybdenum silicide rod. Some of these are promising, especially when used for applying thicker coatings. In a joint communication by members of the staffs of the Battelle Memorial Institute and the Fansteel Metallurgical Corporation,[1] one of the most effective methods of treatment is stated to be the vapour deposition method. Molybdenum can be rendered highly resistant to oxidation by treatment with a hydrogen-silicon tetrachloride atmosphere at 1000–1800 deg. Cent. Deposition temperatures between 1400 deg. and 1700 deg. Cent. are not very critical. At these temperatures a coating of molybdenum disilicide, 0·025mm thick, is formed in about a minute. Coatings 0·025mm thick have completely protected the basis metal for over 4000 hours in air at 1000 deg. Cent. and for thirty hours at 1700 deg. Cent. Thicker coatings, within limits, give proportionately longer lives; but coatings more than 0·08mm to 0·10mm thick, made by this method, have a pronounced tendency to crack. Coatings are, however, continually being improved and lives of 1000 to 2000 hours at 1700 deg. Cent. in air are probable. The maximum practicable thickness of coating is stated to be 0·25mm.

The vapour deposition method is recommended by the authors as an effective way of imparting the corrosion resistance of a silica glass to a highly refractory metal, for use in furnace heating elements, combustion

chambers, turbine blades, nozzles, heat exchangers, &c.

[1] E. A. Beidler, C. F. Powell, I. E. Campbell and L. F. Yntema: "Formation of Molybdenum Disilicide Coatings on Molybdenum," *Journal* of the Electrochemical Society, January, 1951, Vol. 98, page 21.

Mechanical Methods of Reducing Residual Stress

RESIDUAL stress in cold-drawn materials may be reduced by a low-temperature annealing treatment. In the case of cold-drawn steel bars the temperature required is fairly high. For example, the residual surface stress in a 2in diameter cold-drawn mild steel bar was reduced from 38 to 21 tons per square inch by a two-hour treatment at 400 deg. Cent., but a temperature of 500 deg. Cent. was required to reduce the stress to 2·5 tons per square inch.[1] With such a temperature there is some risk of deteriorating the surface quality of the bar, and of a slight softening effect on the tensile properties.

It has long been known that a redistribution of stress with a lowering of the peak values may be obtained by mechanical means. For

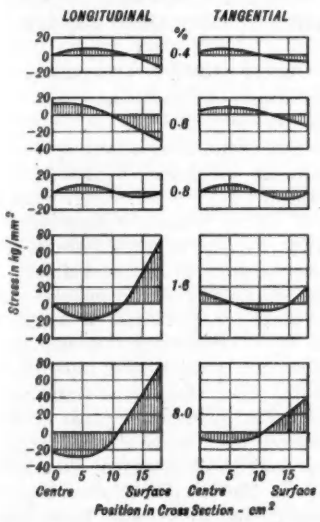


FIG. 1—*Influence of the Amount of Cold Drawing (0·4 to 8 per cent Reduction of Area) on the Distribution of Residual Stress in a Cold-Drawn 50mm Diameter Bar of a 33-Ton Steel.**

example, in February, 1935, the Vereinigte Stahlwerke A.G. obtained a British Patent (No. 423,868) for a "Process for Lowering Internal Stress in Metal Work Pieces Subjected to Cold Working." In this specification the detrimental effect of residual stress in cold-worked material was described, and it was claimed that the residual stresses produced by cold drawing a steel bar were largely eliminated by redrawing with a very small reduction of area. An example was quoted of how the residual stress in a 33-ton steel, cold drawn 8·5 per cent, was reduced by over 70 per cent by redrawing with a reduction of 0·6 per cent.

This information has been amplified, and work on these lines extended by H. Bühler and E. H. Schulz.[1] The sense, amount and distribution of residual stress in a cold-drawn bar are dependent on the reduction of area undergone. With considerable reduction there is compression at the centre of the bar and tension at the surface, whereas if the amount of reduction is small the surface is in compression and there is tension at the centre (Fig. 1). In a 50mm diameter bar, the reversal of sign occurs at about 0·8 per cent reduction of area in 33-ton steel and at about 0·5 per cent reduction of area in a lead-bearing 60 : 40 brass. From this behaviour it may be expected that the original tensile stress at the skin of a cold-drawn steel bar would be lowered by the superposition of a compression stress induced by a small reduction of diameter in a subsequent cold-working operation. In factory test the bars went through an additional drawing operation; in the laboratory short lengths were pressed through a die. The effect is shown in Fig. 2. The maximum residual longitudinal tensile stress of 34 tons per square inch in the bar cold drawn from 50mm to 48mm diameter was reduced to 10 or 12 tons per square inch by a second drawing to 47·8mm diameter, and to 7·5 tons per square inch by a further drawing to 47·75mm diameter. The amount of reduction in the second cold-drawing operation is somewhat critical, and must be carefully controlled. A reduction in diameter of the original

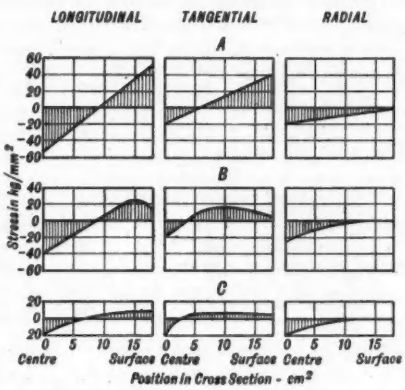


FIG. 2—*Residual Stress in a Steel Bar (Carbon 0·19, Manganese 0·93, Copper 0·68 and Chromium 0·43 per cent) Cold Drawn from 50mm to 48mm Diameter (A), and the Effect of Pressing Through a Die to (B) 47·8mm and (C) 47·75mm Diameter (Bühler and Schulz)*

cold-drawn bar from 48mm to 47·7mm, though causing a redistribution of the stresses, was less effective in eliminating longitudinal tensile stress (Fig. 3). The two stages of cold drawing can be combined into one operation, and the bar drawn through two dies arranged in series with a sufficient distance between them for the bar to be lubricated before it enters the second drawing stage. In a 0·18 per cent carbon steel, cold drawn from 50mm to 48mm diameter, the residual surface tensile stresses were 27 tons per square inch longitudinal and 20 tons per square inch tangential. In the second stage the bar was reduced to 47·9mm diameter and the stresses to 4½ and 5 tons per square inch respectively. A bar subjected to the combined operation showed a final longitudinal surface stress of less than 4 tons per square inch.

A beneficial stress-relieving effect is attained not only by drawing through a die, but by any form of cold work which will impart a small amount of permanent deformation to the surface layers of the steel. Cold work which only deforms a thin surface layer, e.g., surface rolling, press polishing, reeling, sizing, &c.,

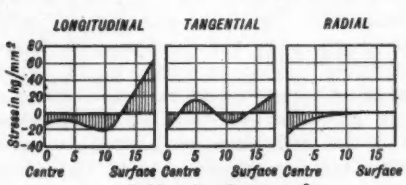


FIG. 3—*Effect on the Internal Stress Distribution Shown in Fig. 2 (A) of Pressing Through a Die to 47·7mm Diameter; Reduction of Area 1·2 per cent (Bühler and Schulz)*

has a much smaller stress-reducing effect than the proposed drawing through a die.

The effect of one such sizing operation is dealt with by H. Bühler in two subsequent papers.[2] In these the reduction of residual internal stress in cold-drawn bars by press polishing is described. A bar, 3m long, of 0·19 per cent carbon steel, was cold drawn from 72mm to 70mm diameter in one pass. It was then cut into 350mm lengths, and turned and ground to 69mm diameter. The residual tensile stresses at the surface were found to be about 27 tons per square inch longitudinally and 22 tons per square inch tangentially. By subsequent press polishing the diameter was reduced by 0·01mm, 0·02mm and 0·026mm. In each case the tensile stress in the surface layers was changed to compression, the maximum longitudinal values of which were 9, 23½ and 38 tons per square inch, increasing with reduction of diameter. The effect upon deeper layers of the material was, however, much less. In a zone below the surface layer tensile stresses exceeding 19 tons per square inch remained. Press polishing can suppress superficial tensions and even reverse them, but it does not always lead to the elimination of dangerous tension within the material. Nevertheless, it is clear that the treatment exercises a favourable effect on the state of stress created by cold working. In current practice cold-drawn steel is given a sizing pass, and there is reason to believe that this supplementary treatment exercises on the internal tension an influence analogous to that described above for press polishing.

The principle of eliminating residual internal stress in steel bar by mechanical means offers

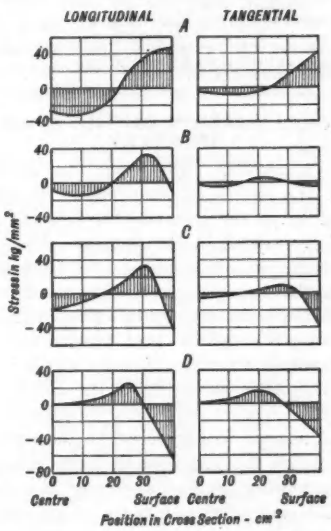


FIG. 4—*Residual Stress in a 27-Ton (Minimum), 0·19 per cent Carbon Steel Bar Cold Drawn from 72mm to 70mm Diameter and Ground to 69mm Diameter (A); then Given a Further Reduction in Diameter of 0·01mm (B), 0·02mm (C), and 0·026mm (D) by Press Polishing (Bühler)*

economic advantages over heat-treatment methods. The authors estimate that, taking the cost of simply drawing as 100, the cost of production including heat-treatment is 290, the cost including intermediate heat-treatments (which, in any case, are not effective in finally eliminating residual stress) is 370, while the cost including the second drawing operation is 122.

It is perhaps desirable to point out that the authors, in recommending these mechanical methods of reducing residual internal stress on the grounds of economy, preservation or improvement of surface finish and maintenance of the mechanical properties of the steel, are concerned only with the tensile and fatigue properties. If restoration of the yield strength in compression is an essential requirement there would appear to be no alternative to the method of heat-treatment at a temperature of about 450 deg. Cent.

[1] H. Bühler and E. H. Schulz, *Stahl und Eisen*, December 7, 1950, Vol. 70, page 1147.

[2] H. Bühler, *Revue de Métallurgie*, April, 1951, Vol. 48, page 299; *Stahl und Eisen*, May 10, 1951, Vol. 71, page 521.

T.S.S. "KENYA."—The new liner for the East African service of the British India Steam Navigation Company, Ltd., T.S.S. "Kenya," which was launched from the yard of Barclay, Curle and Co., Ltd., in November of last year, will run trials on the Clyde in mid-July and sail on her maiden voyage on August 25th.

* 20kg, 40kg and 60kg per square millimetre are equal respectively to 12·7, 25·4 and 38·1 tons per square inch.

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ORGANISATION OF THE STEEL INDUSTRY

FOUR months ago, when, on February 15th, the shares of some eighty companies scheduled in the Iron and Steel Act of 1949, officially vested in the Iron and Steel Corporation, we expressed a fear that henceforth the industry would be ruled, to its grave disadvantage, by a two-headed monster, one of whose heads, that belonging to the Corporation, would have nearly all the power, and the other, belonging to the British Iron and Steel Federation, most of the experience of the industry. We criticised the Government for creating that situation through its haste in implementing the Act at almost the earliest possible date when, in fact, its terms permitted further delay; and doing it at a time when there could be no guarantee that a General Election, which might reverse the whole nationalisation policy, would not take place within a few months or even weeks. For we foresaw the possibility—indeed, the virtual certainty—that the Corporation and the Federation would come into conflict and we doubted whether the new Corporation could be depended upon to act with tact and discretion in building up an amicable relationship with the older and very influential body. For, though the Corporation was certain to assume its own permanence, it was very improbable that the Federation would agree to that assumption. The Federation, in fact, in order not to risk damage to its existing voluntary structure of proved worth, would necessarily try to reach as limited an agreement as possible with a body that it deemed as likely as not would go out of existence quite suddenly within a few months or weeks. That situation was bound to prove galling to the Corporation and might prove damaging to the industry. We felt that the Government had acted irresponsibly in creating it.

So far our fears have not proved very well grounded. The concurrent existence of two bodies, the Corporation and the Federation, one with nominal control of the greater part of the industry and the other with a larger influence over it, has done little harm. For, fortunately, the Corporation has not exerted the powers of compulsion that it appears to possess in face of the reluctance—the very natural reluctance—of the Federation wholly to co-operate with it. But in a speech a week ago to the conference of the Amalgamated Union of Foundry Workers, Mr. Strauss, Minister of Supply, vented the irritation felt by the Government. He did not hesitate to accuse the Federation of using every device, legal and otherwise, to frustrate the Corporation and "to resist to the maximum its efforts to bring into operation the necessary machinery for implementing the intentions of Parliament." Implicitly, he criticised the Federation by remarking upon "the great shortage of raw materials" that, he said, existed at the time of take-over, a criticism that the Federation has effectively answered by quoting stock figures of pig iron and scrap in hand in February for each of the years 1948 to 1951 inclusive. This hostility seems to have been engendered by the recent refusal of the Federation to agree to a proposal of the Corporation that responsibility for the supply of raw materials should fall on the latter body. It led the Minister to utter a threat: "It is essential," he said, "that the conflict be resolved in the near future, I hope, by common sense and a sense of responsibility, rather than by the drastic action which the Corporation will otherwise be forced to take." That, it seems to us, is an irresponsible statement in itself. For was not a conflict between the Corporation and the Federation predestined to occur when the Government decided to enforce the Act last February? The conflict is the direct consequence of the Government's haste, and it is one that can only be finally resolved at the polls.

It is obvious enough that the Corporation must be sorely tempted to take the "drastic action" to which Mr. Strauss referred. For its present situation is embarrassing to itself and to the Government, and may seem to its members undignified. But though the Corporation has great and positive powers, its future is so uncertain that nothing but harm could follow from the attempt to use them. That common sense which Mr. Strauss himself invoked surely dictates that in this uneasy interim before another Election at last decides the issue, the Corporation should endeavour, through the application of restraint and tact, to earn the respect of the industry rather than enter upon a jealous struggle for its leadership. Were the next Election to bring the Labour Party back into real power, the leaders of the steel industry, like the leaders of other industries, would, no doubt, bow before the inevitable. Then if the Corporation had earned their respect before, it could confidently ask for their co-operation after the Election. But any attempt now by the Corporation to exert in full the powers that it possesses to compel obedience amongst the leaders of the Federation—leaders who feel that the present situation gives every hope of a successful resistance—must alienate them; and leaders exasperated by a bitter struggle now would find it difficult indeed to swallow their resentment later should the Election favour nationalisation. Could the Corporation successfully run the industry without their co-operation?

THE SUPPLY OF ENERGY

THE discovery, some six years ago, of means for releasing nuclear energy from the atom, raised high anticipation that here might be found a new source of mechanical power which could replace the fuels of to-day when the supplies of these begin to give out, or when their production becomes too arduous for the available labour. In the early days of the discovery it was optimistically hoped that a model plant might be in experimental service within a few years but in the light of later knowledge it became clear that, to meet the practical difficulties in constructing plant of so novel a character, far more time would be required for the work of development than had been expected. The number of years began to be estimated, by those who knew most, in decades rather than years. A leading exponent of caution in making forecasts was Sir John Cockcroft, the scientific chief at Harwell, whilst Sir Harold Hartley, in his presidential address to the Birmingham meeting of the British Association endorsed the conclusions of the Fourth World Power Conference that the difficulties to be overcome before the use of nuclear energy became practicable must prove formidable and require intense and prolonged effort.

It thus became natural to wonder whether the anticipation of this "jam to-morrow" would prove so remote in realisation that its advent might be hardly in time to afford an adequate supply of power before existing stores in the earth had begun to show signs either of exhaustion or of unavailability. Fortunately, at the same B.A. meeting as that over which Sir Harold presided, a comprehensive paper was presented by Dr. A. Parker, Director of Fuel Research, in which quantitative estimates were given for the various current sources of energy, as well as for current rates of consumption. At a first glance the resulting energy balance sheet looks remarkably favourable, for the world reserves of coal and lignite should, it seems, suffice for a thousand years or more at the present rate of consumption; though one needs to bear in mind the fact that these buried stores had hardly been touched before the beginning of the nineteenth

century and that if another such spurt in activity occurred, the balance sheet would begin to look very different. Dr. Parker gave an estimate that since the beginning of historical records 85,000 million tons of coal and nearly 10,000 million tons of petroleum have been used up and that half the coal had been produced and used within the last thirty years and half the petroleum within the last ten. Moreover, not all countries are equally endowed. Such countries as the U.S.A. and U.S.S.R. may be relatively well provided, but Germany, for instance, has only one-fifth as much (400 years supply instead of 2000), and Great Britain as little as one-tenth, whilst some countries have none at all. Estimated by continents it seems that Asia with half the population of the world, has less than one-fifth of the total coal and lignite, whilst its population is fast increasing.

The state of the store of petroleum needs also to be taken into account, though its future is hard to predict; indeed, an estimate made only fifteen years ago put it at some 4000 million tons, which, as it happens, is just about the amount produced and used during that interval, whilst the present reserves are now estimated at 13,000 million tons! Even so, the aggregate energy value is comparatively small, less indeed than 1 per cent of that obtainable from the estimated coal reserves, and to convert any appreciable portion of this into oil fuel would be an elaborate and expensive process. Not much in the way of mechanical energy can be expected to prove available from any tapping of the heat energy of the earth's interior, nor from the daily supply of solar radiation, since both are very hard to collect; though the solar radiation is, of course, vital to life, whether human or vegetable. The total consumption per head of population of energy from all sources is estimated to be equivalent to some 8 tons of coal per annum in the U.S.A., compared with about half that amount in our own country and as little as half a ton in such areas as India and China. Incidentally, the 8 tons per annum of the U.S.A. is assessed by Dr. Parker as the human equivalent of some thirty "servants" for each individual, a generous supply, but even in the much less well provided lands the mechanical energy at work should provide quite a number of useful robots for each family home.

It seems a reasonable conclusion that in the more important countries of the world there should be ample time for the preparation of efficient means for the use of atomic energy as an important and in the long run, perhaps, the most important, source of supply of mechanical energy for civil purposes as well as for the design and construction of the huge plants necessary. But there is a fly in the ointment. This highly desirable issue may be gravely hindered and delayed if it should happen that some of the substances produced during the process prove to be such as to require severe restriction in use because of their applicability to warlike ends. It is true that the American Lilienthal Committee suggested that means might be found for "denaturing" such products, but so far there is little indication of anything of the kind being available; happily, the time limit for the making of such a discovery is fairly generous.

Obituary

H. A. SIEVEKING

We have learned with deep regret of the death of Mr. Herbert Alfred Sieveking, M.Sc., M.I.C.E., which occurred at 9, Castlebar Road, Ealing, W.5, on June 20th, after a very short illness, at the early age of forty-six. In addition to being an engineer, Mr. Sieveking was a member of the legal profession having been called to the Bar at the Middle Temple in November, 1938.

Mr. Sieveking, who was the son of the late Dr. A. R. Sieveking, was born at Bristol on October 12, 1904. He received his general education in Switzerland and at Trent College, Long Eaton, Derbyshire, and studied engineering at King's College, London, where he graduated in 1925. Sieveking then went for practical training to the Rugby works of the British Thomson-Houston Company, Ltd., where he remained for three years. At the end of that time, he joined the export section of the B.T.H. switchgear department at Willesden. In 1929, he took up an appointment with J. M. Voith, Heidenheim, Germany, and for the next year or so was engaged in the design and layout of various hydro-electric schemes.

On returning to this country in 1930, Mr. Sieveking joined Perrins, Ltd., Westminster, as a consulting hydro-electric and electrical engineer. There he was responsible for the preparation of the mechanical and electrical sections of a large number of power schemes and factory equipment projects. He remained with the firm for three years, and then became a supply contracts engineer with the Central Electricity Board. Mr. Sieveking continued with the C.E.B. until 1940, his duties in the early part of the war being concerned mainly with electricity supplies to Government factories and the preparation of the agreements associated therewith. In November, 1940, he went to James Howden and Co., Ltd., Glasgow, as chief electrical engineer, and, in addition, for the next five years, acted as that company's technical legal adviser. In 1945, Mr. Sieveking joined the hydro-electric department of the English Electric Company, Ltd., and worked at Rugby, Stafford, Glasgow and London, He was largely concerned with hydro-electric projects and examined hydro-electric prospects in Canada, Brazil and India. He also lectured on hydraulic turbine design at the Imperial College of Science and Technology in the post-graduate course on "Hydro-Power Engineering," and in the early part of this year, gave a series of lectures at King's College, London, on "Some aspects of the Development of Hydro-Electric Power."

Mr. Sieveking held the M.Sc. Degree of London, and was a member of both the Institution of Civil Engineers and the Institution of Electrical Engineers. For his papers, he was awarded the Institution of Civil Engineers' Joule Medal and the Telford Premium and, also, an extra Premium of the Institution of Electrical Engineers for his paper on "Electrically Manufactured Steels." He was a fluent linguist with a good command of the German and French languages, and had many interests apart from engineering.

A Lancashire Firm's Jubilee.—The fiftieth anniversary of Ashworth and Parker, Ltd., Riverside Works, Bury, Lancashire, is being celebrated this year. To commemorate the event, the firm has produced an illustrated brochure setting out its history and recording its development. The business was started in 1901 by two Bury engineers, Mr. W. A. Ashworth and Mr. W. S. Parker, with the primary object of building vertical enclosed forced-lubrication steam engines, products which are described in the brochure.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PRESENT-DAY LOCOMOTIVE WORKING IN GREAT BRITAIN

Sir,—I have read with interest Mr. Smith's letter on the subject of the fuel and water consumptions of the Class "5" locomotives during the Exchange trials. However, it seems that there must be some error in the figures he quotes. Either the staff of British Railways have incorrectly estimated the most economical overall time or there is an error in the allowance for the out of course checks. With due respect to Colonel Rudgard, I feel the latter is more likely to be incorrect, as the figures given by him are only approximations. Unfortunately, at present I am unable to refer to his paper, so cannot discuss the matter in as much detail as I would wish.

The question is to decide at what overall speed the sum of the coal required to provide for the work of moving the train, and for the heat lost from the boiler, is a minimum. The work performed on the train increases with rising speed, as was shown recently in these columns for the "Britannia" class, but the shorter the overall time, the less heat is lost by the boiler and cylinders as radiation, convection, &c. It may be that the curve of efficiency against overall time has a very flat maximum, but the greatest thermal efficiency is only produced at one point, and this will correspond with the lowest coal consumption.

I had recalled Mr. Carling's qualifications regarding the practical possibilities of reducing the time of the train in question to four hours, but if it is possible to achieve the performances noted by Mr. Nock over one main line, it should be equally possible over another. My attention will probably be drawn to the state of the track, but I would still ask where the difference lies between one main line and another. Both can be given identical attention, and the people who would benefit are the travelling public.

I agree with Mr. Smith that 5 cwt of coal a day could not be saved by every Class "5" engine. In most cases the saving resulting from working at maximum efficiency would be more, probably a lot more! Of course, this could not be achieved in practice to any great extent, but surely this points to one of the dangers of over-standardisation of engines rather than parts.

While inspecting "Britannia" recently I was particularly struck by one small feature, which, I think, deserves mention. A spring is incorporated to help balance the uneven weight on the reversing shaft, and so ease the work of the driver. This is surely the most sensible arrangement. So many locomotives have carried balance weights, weighing several hundredweight, for countless (and needless) thousands of miles and will continue to do so until more logic is shown.

Peter W. B. Semmens

Middlesbrough, June 15th.

Conference of Naval Architects and Marine Engineers

The formal opening of the International Conference of Naval Architects and Marine Engineers by the Lord Mayor of London, on Tuesday, June 26th, was preceded by a reception, held by the chairman and committee of Lloyd's Register of Shipping, to meet the delegates of the conference. The guests were received by Sir Ronald Garrett, the chairman, and Lady Garrett, and Mr. A. E. M. Gale, the deputy-chairman and treasurer, and Mrs. Gale. In addition to the large number of delegates from various countries, the Ambassadors of the Argentine, Brazil and Italy were present, together with the High Commissioner for New Zealand, the acting High Commissioner for Australia, and the Israeli Chargé d'Affairs.

The Royal Show at Cambridge

No. I

THE Royal Show, organised annually by the Royal Agricultural Society of England, is being held this year at Cambridge. It will open on Tuesday next, July 3rd, and will continue until Friday, July 6th.

This is the fourth occasion in the long history of the Royal Agricultural Society that Cambridge—which has now been elevated to the status of a city—has been selected as the venue of the "Royal." The first time the show visited Cambridge was in 1840. It was the second "country meeting" arranged by the Royal Agricultural Society and lasted for two days, about five acres on Parker's Piece being required for the display of 352 livestock entries and the thirty-six machinery exhibits. The show was open to the public on the second day only, from 6 a.m. to 7 p.m., the number of people attending being estimated at 25,000. The programme of the first show at Cambridge included a ploughing match and also a dinner for 2650 persons, to accommodate whom a special pavilion was built in the grounds of Downing College. The committee of the Society made provision for a very satisfying meal, and was also thoughtful about the comfort of its guests, for a minute records that, because at the Show of 1839 the diners had nowhere to put their hats, "it is proposed to remedy that inconvenience by nailing a piece of twine opposite each seat on the underside of the table, to which the band of the hat may be tied." In these days of increased and increasing costs it is of interest to recall that, in 1840, the committee allocated the sum of £1 10s. to pay for "nails, twine and labour for 2500 hats!" About the implements exhibited at the 1840 show at Cambridge, the judges expressed the opinion that "the attention of some implement makers had been directed more to novelty and ingenuity of design than to skill in execution." Medals for new implements, however, were awarded to the manufacturers of a tile-making machine, a drop-drill for manure, a corn and turnip drill with a movable roller, a liquid manure cart, and a "skeleton" harvest cart for one horse.

When the Royal Show next visited Cambridge, in 1894, it was staged on Midsummer Common, occupying about sixty-four acres, the attendance numbering about 112,000. There were 1864 livestock entries and a total of 6031 implements displayed on 442 stands. In this journal, at the time, we commented that it was certain that the portable, semi-portable and traction steam engine had reached finality, and that the engineering interest of the show centred around the "unsavoury oil engine." A trial of stationary oil-engines, organised in connection with the show, attracted twenty-six entries.

The third "Royal" to be held at Cambridge was in July, 1922, in very wet weather. On that occasion a site of 120 acres at Trumpington was taken and the livestock entries, 4200, were a record. The number of implements exhibited was 4866, the new implement competition for the Society's silver medals attracting an unusually large entry.

The 1951 Show

For this year's show, a 150-acre site at Trumpington—2½ miles from the City of Cambridge—has been prepared. The ground is roughly square in shape, with thirteen avenues crossing it from east to west and three main avenues from north to south. Running northwards through the showground is Hobson's Brook, named after Thomas Hobson, the famous Cambridge carrier, and constructed in 1610. It was, in fact, a joint effort by the University and prominent local citizens, of whom Hobson was one, to bring fresh water from Trumpington to Cambridge, not so much for domestic purposes as to flush the King's Ditch, which was then an unpleasant open drain. In Cambridge itself, the brook still flows along open water-courses in Trumpington Street and supplies the fountain in the Market Place. That part of the brook flowing through the showground is crossed by thirteen bridges, twelve of which have been specially built for the occasion.

This year's "Royal" is under the presidency of Colonel H. J. Cator, the honorary director of the Show being Mr. Michael Mason. The consulting engineer is Mr. S. J. Wright, M.I.Mech.E., and the secretary, Mr. Alec Hobson. Nearly half the showground will be taken up by the trade and machinery stands, which will occupy seventy acres. Sixteen implements have been accepted for final judging in the Royal Agricultural Society's silver medal competition. A condition of this competition is that entries must fulfil a purpose of value to agriculture, for which no machine has hitherto existed or, if the purpose is not new, some new principle of working must be embodied. For the first time this year a perpetual challenge trophy, given by Sir Roland Burke, is to be awarded to one of the new implement entries, if it is considered to be of exceptional merit.

An exhibit of particular interest in this Festival of Britain year will be a historical display of farm implements and machines made 100 years ago, some of which are still in use. This display is in six parts, illustrating ploughing, cultivating, seeding, harvesting, threshing and the use of barn machinery. It will include a farm cart and several models, which were exhibited at the Great Exhibition of 1851; an early iron plough, which was used on a Hertfordshire farm until 1939; a replica of the original McCormick reaper; an early portable steam engine; a two-horse wood-framed mower, and a winnower built in 1853.

In what follows we begin a description of some of the implements and machinery which will be shown on the trade stands next week.

Harry Ferguson, Ltd.

Several additions to the range of implements now in production for operation with the hydraulic lift of the Ferguson tractor are to be exhibited by Harry Ferguson, Ltd., Coventry. One of them is a reversible single-furrow plough, which is entered for the new implement competition. This plough, which is illustrated in Fig. 1, has been designed for a working width of 16in to 18in. Right-hand and left-hand deep digging bases are mounted, together with their disc coulters, on a central beam at an angle of approximately 80 deg. to each other. This central beam is supported in a tubular construction having horizontal arms and a vertical strut for the tractor's three-point linkage, the tube being fitted with bearings and seals at either end to contain the lubricant and exclude dirt. To the front end of the central beam there is fixed a latch plate, which, with a latch mounted on the tubular structure, locks the plough

FIG. 1—MOUNTED REVERSIBLE PLOUGH—FERGUSON

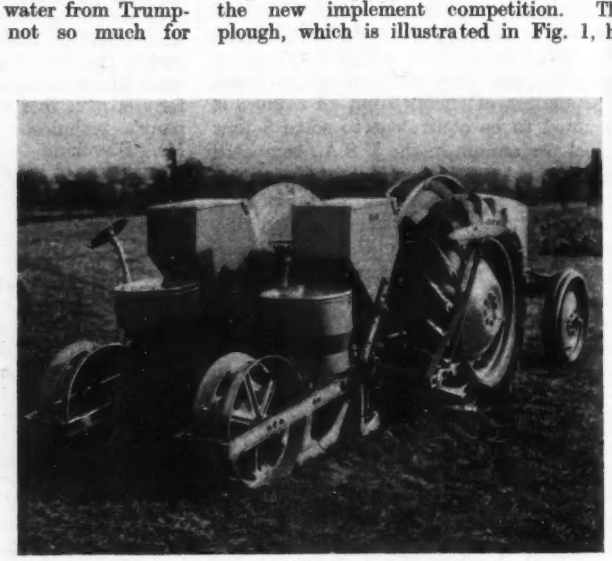


FIG. 2—PRECISION SEEDER—FERGUSON

in the required working position. The latch is depressed by a plunger in an indexing arm, which pivots on the front of the centre beam, the position of the indexing arm being controlled by a cam mechanism and "over centre" spring mounted on the latch plate. The plough beams, attached to the rear of the centre beam, may be independently adjusted for angle in the vertical fore and aft position—to control the width of the furrow—by means of set-screws. The plough is controlled for depth and lifted for transport by the hydraulic mechanism of the tractor.

In Fig. 2 we illustrate a precision drill suitable for such crops as maize, peas, beans or cotton, which require variable row widths and the accurate and uniform spacing of the seeds in each row. Basically this machine consists of two cylindrical hoppers mounted on a steel rowcrop frame near the ground in order to maintain accuracy during the fall of the seed. Serrated plate-seeding mechanisms are located in the bottom of the hoppers and are driven independently by chain from the covering wheels. The drill is coupled to the tractor in a manner that permits the hitch to pivot horizontally and laterally, thus allowing the planting units full freedom to follow ground contours. If required, individual fertiliser hoppers with a capacity of about 2 cwt can be added to this implement, their distributor mechanisms being of corrosion-resistant material. Fertiliser placement in relation to the seed row may be adjusted to 2in to either side.

The Ferguson tractor exhibits will include a four-cylinder diesel, which the firm is now putting into production. The weight of the tractor has been kept down to less than 24 cwt, and at 2000 r.p.m. the engine is capable of developing 25 belt horsepower. An industrial tractor, available with petrol on t.v.o. engine, and an "extra narrow" tractor are also to be shown. The width of the latter over rear tyre and rim is 41½in and over the front hub covers 46in.

The Butterley Company, Ltd.

The half-track conversion, which will be shown by the Butterley Company, Ltd., Derby, is made by James A. Cuthbertson, Ltd., Biggar, Scotland. It is one of the items accepted for the new implement competition and, at the Royal Show, is to be exhibited on a Fordson "Major" tractor. As will be seen from the illustration, Fig. 3, however, the half-track can be fitted to any standard wheel tractor. The Cuthbertson track is composed of a number of rubber and wire rope links, which have been designed so that the stresses are equally distributed over eight ropes, each capable of withstanding a pull of 2·3 tons. In the case of the Fordson "Major" the maximum drawbar pull is under 5000 lb, and when this is distributed over two tracks the maximum stress coming on to each rope is in the region of 3 cwt. Provision has thus been made for an ample factor of safety. The tread, from centre to centre of tracks, is 52½in; length of track on ground, 36in; width of track shoes, 13in; height of grousers, 1½in; diameter of track-shoe bolts, ⅝in. There are eleven track bolts to each pad. The half-track is mounted on a simple frame, it being necessary to loosen six bolts only to remove the frame from the tractor in order to replace the wheels.

Another interesting item of Cuthbertson equipment, to be shown on the Butterley stand, is a tube-laying attachment to a drain cutting machine. The attachment consists of a drum for holding the coil of tubing, and a mouldboard, which cuts through the ground and lays the tubing at any desired depth from 12in to 36in. A tractor of the 30 h.p. to 40 h.p. class is needed for pulling the machine, which has been designed for laying "Alkathene" plastic pipes or copper pipe of up to 1½in diameter. The speed of laying is claimed to be about 3 miles an hour.

FIG. 3—HALF-TRACK CONVERSION—CUTHBERTSON

FIG. 4—THE "ROTOFLAIL"—PEST CONTROL

Pest Control, Ltd.

For disintegrating tall weed growth and other unwanted vegetation to form humus, Pest Control, Ltd., Harston, Cambridge, has introduced the "Rotoflail," a photograph of which is reproduced in Fig. 4. It is among the machines competing this year for the Royal Agricultural Society's silver medals. The frame of the "Rotoflail" is of all-welded channel section steel, there being a sheet steel cover, which is easily removable for inspection and maintenance purposes. The flail assembly is made up of a rotor shaft mounted in sealed bearings and carrying 108 solid rubber flails. The implement is driven by the power take-off of the tractor, the drive being transmitted through a universal power shaft and couplings, whence it is carried to the rotor shaft through a reversible gearbox and chain and pinion assembly, giving a working speed of 700 r.p.m. The wheel brackets are made from double-section channel steel and the stub axles of high tensile axle steel. Tapered roller bearing hubs are fitted and the two wheels, which are of pressed steel, are equipped with pneumatic ribbed implement tyres, 6.00×16. The track is adjustable between 34in and 42in. The flails give a swath width of 7ft and are adjustable for height between 0in and 8in. The principal dimensions of this new implement are width 8ft 1½in, height 3ft 6in, length 10ft. Its total weight is 1500 lb.

The firm will also show representative examples of the crop spraying equipment, which it manufactures. In recent years, a good deal of attention has been given to equipment for preventing drift of liquid sprays and also for giving additional protection to tractor operators when spraying insecticides and weedkillers. Equipment of this kind, developed by Pest Control, Ltd., includes the "Nodrif" spray boom and an air-conditioned gas-proof tractor cab, which were described in our issue of April 13th last.

(To be continued)

Creep and Fatigue at High Temperatures

A MEMORANDUM entitled "Research on Creep and Fatigue Properties of Metals at Elevated Temperatures," has been issued on the recommendation of the Non-Ferrous Metals Committee of the Inter-Service Metallurgical Research Council, with the object of giving an opportunity to all investigators working in this field who may wish to do so to modify and direct their researches in such a way as to contribute the maximum amount of useful information on the behaviour of metals and alloys when subject to creep and fatigue conditions at high temperatures. The recommendations contained in this memorandum, which has been communicated by the Ministry of Supply, are given below in an abridged form.

Factors Recommended for Consideration

Factors relating to the matrix:—Grain size; orientation; the effect of prior mechanical strain and of the manner in which this is effected; effect of solute metals present; effect of small amounts of dissolved impurity and crystal structure of the matrix crystals.

Factors relating to the second, "dispersed" phase:—Uniform or grain-boundary distribution of particles; particle size; amount and nature of second phase present.

Temperature dependant factors: Recrystallisation; grain growth; absorption or globu-

larisation of precipitates, &c., and the influence of stress on such structural changes.

Materials Recommended for Study

Although aluminium alloys were primarily in mind at the outset, a number of different solute and solvent metals must be considered if information of general application is to result. It is clearly necessary to choose for examination systems of known constitution in which there is a reasonable prospect of studying the above factors separately. Pure materials should be used so that the effects of impurities may later be investigated separately, and in the initial stages of the work the materials should be in structural equilibrium at the temperature of the test prior to the start of the test. The resulting information will provide a background against which subsequent work on the behaviour of non-equilibrium structures is less difficult to interpret. The importance of a full and detailed description of the specimens tested and of their method of manufacture, including surface finish, cannot be overemphasised.

Factors relating to the matrix: Alloy systems particularly mentioned as worthy of consideration in this part of the work are the aluminium-zinc, aluminium-magnesium alloys, and copper-base alloys, in which the valency of the solute can readily be varied (the lattice distortions produced by a large number of elements in copper are accurately known and can therefore be directly compared with mechanical properties). Magnesium alloys, such as those with cadmium or aluminium provide materials based on a hexagonal metal, and iron which can exist in face-centred cubic and body-centred cubic forms provides an opportunity of correlating properties with changes in crystal structure.

Factors relating to the second phase: Systems in which the second phase is completely insoluble in the solid state are difficult to find, but some work is in progress in co-operating laboratories on aluminium-iron and lead-copper systems where this condition is approached.

The effects of the mode of occurrence, distribution, and particle size of a dispersed phase could be studied in the system aluminium-copper about the precipitation processes in which much is already known. In this case a definite intermetallic compound of limited homogeneity range is formed. Research should preferably be planned to include the effects of different types of dispersed phase. Many systems of the "aluminium plus intermetallic compound" type are available, while in the system aluminium-magnesium there is an intermediate phase of relatively wide homogeneity range. It may be necessary at some stage of the work to extend investigations to the effect of second phases of the "electron compound" type, in order to complete the picture.

Temperature dependent factors: The effect of these variables could be examined in the aluminium-copper system or perhaps, better, in some system such as aluminium-magnesium where the variation of solubility with temperature is more pronounced.

General Observations

It cannot be too strongly emphasised that there is no desire or intention in the minds of the Committee to direct researches on creep and fatigue of metals into any unduly narrow channel. The Committee's object is only to call the attention of all interested parties to the desirability of carrying out work in this field on such materials and in such a way, wherever possible, as to make the most effective contribution to our knowledge of the subjects.

The Non-Ferrous Metals Committee would welcome information as to the particular researches of investigators working in this field. Those interested should communicate with the Secretary, Non-Ferrous Metals Committee, Inter-Service Metallurgical Research Council, Metallurgy Department, Royal Aircraft Establishment, Farnborough, Hants.

The British Electricity Supply Industry*

This is the third of the conferences which have been held under the auspices of the British Electricity Authority since the industry was nationalised in April, 1948. It has been my practice at these conferences to review in general outline some of the major activities and problems of the organisation. In the national sphere, the industry has encountered many grave problems since the conference met last year. Shortage of coal caused much anxiety during the winter months and although, happily, the outcome was less serious than had been anticipated, further prospects are by no means clear. Present inflationary trends and the strain on material and manpower resources caused by rearmament are raising problems in all sections of the industry.

The number of consumers is now over 13 million, representing an increase of 457,000 during the year and about 1½ million more than there were on the Vesting Date. The Central Authority and the fourteen Area Boards employed at March 31, 1951, approximately 176,000 employees. The increase during the year 1950/51 was approximately 5500.

The number of units sent out from the Authority's stations in 1950/51 was some 52,525 million, as compared with 46,383 million units in the previous year, an increase of 13·2 per cent. This figure is somewhat inflated by the severe weather which was experienced during the year and by the fuel shortage, which no doubt caused consumers to use electricity in order to conserve their stocks of fuel. Promotional advertising evidently did not effect it very much, judging by the results, since such advertising was discontinued in December, 1950. Since that time the increases over the corresponding month in the previous year have been January, 1951, 12·8 per cent; February, 12·9 per cent; March, 14·1 per cent; and April, 16·7 per cent. There is no sign of any diminution in the rate of increase and the peak load deficiency, with which the industry has been grappling since the Vesting Date, far from being solved, is being steadily accentuated.

The shortage of generating plant has naturally meant that the existing plant has had to be run for longer periods and has been more heavily loaded. The maximum simultaneous demand actually supplied during the year occurred on Friday, December 22nd, and amounted to 11,468MW. This represents considerably more than has ever been carried by the system at any period in its history and compares with a maximum of 11,022MW in 1949/50, 10,163MW in 1948/49 and 9501MW in the winter preceding the Vesting Date.

The overall thermal efficiency of generation continues to rise as new high efficiency plant is brought into commission; the figures for the years ending at March 31st being: 1948—20·86 per cent; 1949—21·15 per cent; 1950—21·33 per cent; 1951—21·5 per cent. As Sir Henry Self said in his presidential address: "an increase of only 0·1 per cent in thermal efficiency represents a reduction in coal consumption of roughly 140,000 tons—or an annual saving of some £350,000!"

Plant Outage

Unfortunately, certain other features of plant operation were not so encouraging. The total plant out of commission due to breakdown, overhaul, unsuitable fuel and other causes, was 14·9 per cent in the month of January, 1951 (which is the month in which the peak load usually occurs) as against 11·4 per cent in January, 1950, although this was still an improvement upon the outage at the peak period in 1947/48, which was 15·1 per cent. Much of the loss of capacity has been due to "teething" troubles on newly commissioned plant but it is most disappointing to find that the breakdown figure increased from 6 per cent in January, 1950, to 7·2 per cent in the current year.

The possibilities of augmenting the maintenance staffs at the power stations by borrowing men from large industrial firms and possibly from the Area Boards, is being urgently examined. Throughout the courses for boiler house operatives, which have been held at Horsley Towers and at Buxton, emphasis has been placed on the importance of securing better operation and less outage. The decision of the Government to rescind, in October next, the Order which lengthened the period of compulsory inspection of boiler plant from fourteen to eighteen months (which was come to without any consultation with the Central Authority) far from easing the present situation, is likely to have the opposite effect. Strong representations have been made against the implementation of this decision.

The consequences of the increase in consumer demand at peak periods, coupled with the increase of outage, has been that in recent months load shedding has been on a greater scale than ever before. Other contributory factors were the reduction in the amount of load spreading in industry during the vital months and the generally colder weather during the winter period.

In the year ending March 31, 1951, load shedding, either by voltage reduction or disconnection of supply, was necessary on 267 occasions, compared with 124 in the previous year. The maximum amount of load shed at any one time was in the region of 2 million kilowatts, equivalent to about 15·8 per cent of the total potential demand on the system at that time. This compares with the maximum of 10·6 per cent in 1949/50.

It has been estimated that a fall of 1 deg. in temperature results in an increase of 100MW in load. On one occasion there was a fall of about 14 deg. in temperature, to meet which would have required more than the whole output of Hams Hall and Barking, the two largest stations in the country. It cannot be emphasised too strongly that it is utterly impossible for us to keep a substantial amount of plant in reserve for emergencies. The plain fact is we have no reserve.

The gross capacity of plant installed has risen to 14,590MW, as against 13,784MW at April 1, 1950 and 12,584MW at the Vesting Date. The output capacity of the plant commissioned in each year, as measured in megawatts sent out, has risen from 340MW in 1947 (the last complete year before the Vesting Date) to 965MW in 1950. Substantial as this improvement has been, it is by no means sufficient and the gap between supply and demand is widening.

Curtailment of Generating Plant Programmes

It seems curious that in such circumstances the need for an adequate supply of generating plant is being questioned.

When we compare our modest goal of 1800MW to be reached in five years' time with the 5786MW which was commissioned last year in the United States, such criticism appears to be ludicrous. Yet some of the critics of our programme are amongst those who stress the great advantage possessed by the American worker, who has at his disposal over three times as much electrical horsepower as the British worker.

It was the aim of the Central Authority to commission at least 1000MW of plant during the year 1951 and it was within the bounds of possibility that a total of 1250MW might be attained. The programmes for succeeding years are devised on a rising scale, it being considered both necessary and practicable to attain a figure of 1800MW in 1956. Our hopes have been very considerably damped by the effects of the rearmament programme and also by the Government's decision to limit our programme to a maximum of 1500MW in any year. Both these factors will have far more serious consequences than are generally

*Abstracts from an address by Lord Citrine (Chairman of the British Electricity Authority) to the British Electricity Conference, Brighton, Monday, June 18th.

realised and if our investment programme is still further curtailed, industry, commerce, and the public generally must realise that there may be a shortage of electricity, particularly in severe weather, for a decade.

Let me deal first with the effects of rearmament. Several months ago I expressed disquiet at the prospect of rearmament placing our programme in jeopardy. I then urged that our programme should be given the highest priority in any system of allocation of steel and other materials. Since that time the position has deteriorated and we have received many requests from our Divisions and from contractors engaged on power station construction, for urgent assistance to help them to obtain the delivery of overdue steel and to induce the mills to accept orders which they had previously rejected.

The Ministry of Supply and the British Iron and Steel Federation have been kept informed of the difficulties we are experiencing, and there is a suspicion that not only are our demands not being satisfied but that steel intended for the British Electricity Authority is being diverted to meet other needs. Civil engineering work has been stopped on some sites due to the lack of reinforcing steel and the position is likely to get very much worse in the next few months. On the plant side, contractors are also reporting many serious difficulties, which they are experiencing due to the lack of steel. An equally serious position has developed in respect of other raw materials, such as copper, zinc, nickel and molybdenum. Warning has been given to the Government that unless something is done immediately to rectify the position by giving the British Electricity Authority requirements top priority, the plant commissioning programme cannot possibly be carried out.

From the point of view of the commissioning of new generating plant the prospects are grim. Unless some decided improvement takes place we may find at the end of 1951 that we have not succeeded in commissioning as much plant as we did in the year 1950.

It is natural in the circumstances that the Central Authority and the Area Boards should resist any proposed further cuts in our capital investment programme. Severe as such cuts, if enforced, would be on generation and transmission, they would be still more acutely felt in distribution. In the annual report 1949/50, it was stated to be economically desirable that generation, transmission and distribution projects should proceed properly in step and it was regarded as unfortunate that this balanced development might be endangered. Moreover, the system is already overloaded and the urgent need for reinforcement is imperative. It is little wonder that Boards are having to refuse new consumers and so to sacrifice public goodwill.

Proposals for Load Limitation

The unpleasant prospect of an electricity shortage for several years to come is now so apparent that many suggestions have been made to the Central Authority for limiting consumer demand. These include such measures as that of increasing the price of domestic electricity, the installation of load controlling devices which would limit the demand of less essential electrical apparatus at time of peak load and the limitation or prohibition of the sale of electric fires.

The greater use of existing private generating plant, the installation of diesel sets in industry and even the use of old naval vessels to augment the public supply have been put forward at one time or another. All these proposals have been carefully examined, no matter how impracticable some of them may have seemed. Uneconomic as the manufacture of small diesel generating sets undoubtedly is as compared with public large-scale generation, the Central Authority, by arrangement with the Federation of British Industries and with the consent of the Area Boards, have agreed to remove the so-called restrictions on the use of such plant until March 31, 1959.

As a result of the examination which has been made of the use of load controlling devices, large-scale tests were decided upon in the areas of the Southern, Merseyside and North Wales and South-West Scotland Boards. Having regard to the rearmament programme, the shortage of materials and the limited investment resources, it has been represented to the Central Authority that the outcome of these tests cannot be awaited before more positive action is taken to discourage the domestic and commercial use of electricity at peak hours. In response to these representations, a working party has been set up by the Minister of Fuel and Power to which the Central Authority has appointed representatives, to examine more closely the operation of various kinds of load limiters and other means of curtailing domestic, commercial and the less essential loads.

All the Area Boards have been asked by the Central Authority to conduct similar tests to those of the three Boards I have mentioned earlier. It is recognised that, even assuming a satisfactory outcome of these tests, a considerable time must elapse before the necessary number of relays and sets of central control apparatus can be delivered. Manufacturing capacity of such apparatus is understood to be comparatively small and rearmament requirements may limit any expansion. In these circumstances the Central Authority contemplate the placing of orders at an early date for a certain amount of this equipment, rather than waiting until the final details regarding its installation can be worked out.

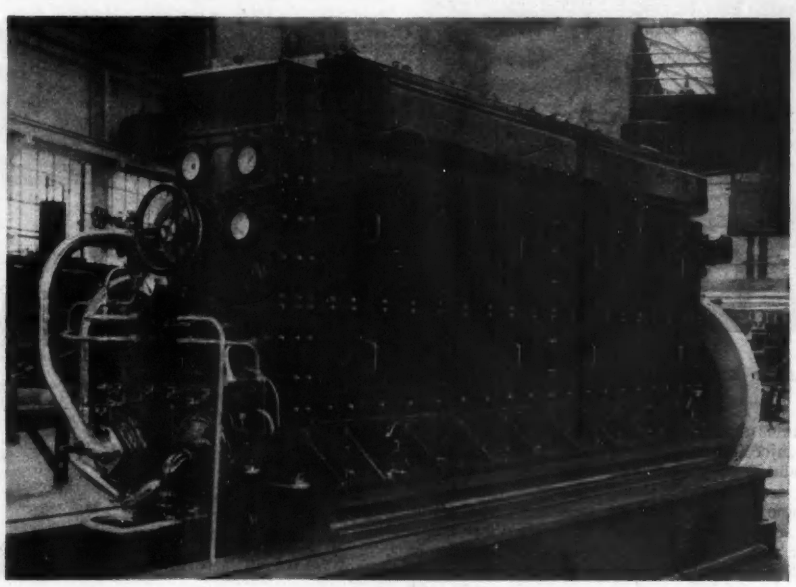
Whatever may be the ultimate value of load controlling devices, there is certainly no convincing evidence of their immediate utility in securing a sufficient redistribution of load to avoid both load spreading and load shedding in the next couple of years.

In Great Britain load control cannot, at the present time, be imposed on a consumer, and the compulsory introduction of such control would not seem possible without the alteration of the present law. There is little doubt in my mind, however, that we are coming nearer to the position where arbitrary action enforceable by law, may have to be taken by the Government to secure a substantial reduction in domestic, commercial and possibly certain kinds of industrial consumption. Any such action in my judgment could not possibly operate equitably between consumer and consumer, but it may be thought that the rough justice which would emerge from such arbitrary action is justified in the extremely critical situation which is developing in the electricity supply industry. I do not consider that the prospects are very good of achieving, by tariff adjustment, any substantial transference of load from the peak periods to more convenient times, except possibly as a long-term policy, to restrictive methods.

I understand and share the repugnance to such methods of all engaged in our industry, proud as they are of its long-established tradition of seeking to supply consumers with electricity at all times when they need it. I feel, however, that unpleasant as the prospect is it is necessary to place the facts as I see them fairly and squarely before this conference.

A Range of Vertical Oil Engines

JUST before World War II the technical staff of Blackstone and Co., Ltd., initiated research to produce an engine having a greater power output per cylinder without increasing fuel consumption, weight and relative cost. The new engine, as planned, had to be a multi-purpose unit, available as a naturally aspirated or turbo-charged engine for land or marine service. Since the war designs have been completed, prototypes approved, production problems solved, new equipment in the way of tools and machines installed and the new engine is now coming off the production line in considerable numbers. Last week we paid a visit to the works of Blackstone and Co., Ltd., at Stamford, to see the new range of vertical engines under construction and also something of the production methods employed. The normally aspirated engines are known as Mark EV, and are available with 2, 3, 4, 5, 6 and 8 cylinders, while the supercharged engines have the mark EVS and are produced with 4, 6 and 8 cylinders. The design, as developed, and the constructional details of the engine, can be seen in the accompanying photographs. From the table on page 872 it can be seen that 45 b.h.p. per cylinder is developed in the normally aspirated engine, and that this is raised to 60 b.h.p. by supercharging, an increase of 33⅓ per cent, the b.m.e.p. of the engines being 86·1 lb per square inch and 115 lb per square inch respectively. The supercharged engines have the turbo-charger mounted on a bracket at the flywheel end and a specially divided exhaust manifold is supplied, as the turbo-charger is driven by the exhaust gases, to consume waste energy. With a compression ratio of 14 : 1, the compression pressure is 470 lb and 560 lb per square inch in the respective engines, while the fuel consumption is given as 0·372 lb



EIGHT CYLINDER ENGINE

CYLINDER HEAD ASSEMBLY

and 0·365 lb per brake horsepower hour at full load.

MATERIALS AND CONSTRUCTION

The engines have a cylinder bore and stroke of 8¾in by 11½in to give a swept volume of 690 cubic inches and a piston speed of 1150 ft per minute at 600 r.p.m. The cast iron, crankcase is of box section design with webs to the mounting flange and it carries the crank shaft in steel backed babbit-lined precision bearings. The cylinder block, also of cast iron, forms a rigid girder when mounted on the crank case and the length is varied, according to the number of cylinders, by introducing additional core boxes between the ends, no additional webs being incorporated and the casting thickness remaining the same for all engines. Single unit cylinder heads, cast in nickel iron, have been adopted and designed to take overhead air inlet and exhaust valves and a central oil fuel injection valve.

Centrifugally-cast wet liners are supplied, and treated with the "Listard" process of chrome hardening; they are secured at the top and free to expand downwards while two rings maintain a watertight seal. The engine is readily accessible and large crankcase doors permit withdrawal of the connecting-rods and pistons without disturbing the cylinder heads.

OUTPUT TABLE.—*Twelve hour b.h.p. rating*

	Normally Aspirated						Supercharged		
Engine Mark	EV2	EV3	EV4	EV5	EV6	EV8	EVS4	EVS6	EVS8
600 r.p.m.	90	135	180	225	270	360	240	360	480
500 r.p.m.	75	113	150	188	225	300	200	300	400
428 r.p.m.	64	96	128	160	192	257	171	257	342

The balanced crankshaft is manufactured under Lloyd's survey from a solid nickel steel forging, heat treated to give a tensile strength of 40 to 50 tons per square inch. Crank pin and journals are ground and oil passages are drilled through the webs to allow lubricating oil to reach the connecting-rod big-end bearings. A flange at the flywheel end of the crankshaft forms a half coupling to which the flywheel is bolted and the bolts extend through to take the half coupling of the driven unit. The connecting-rods are of H-section heat-treated steel stampings and have a through hole drilled for small-end lubrication. Big-end bearings are steel backed and babbit lined with the caps retained by four fitted bolts while the small-end bushes are of chill cast phosphor bronze. All bearings can be replaced with the minimum displacement of working parts. The pistons of close grained cast iron have a toroidal combustion chamber machined in the crown. They are fitted with three compression rings and an oil scraper ring above the fully-floating gudgeon pin and an oil seal ring below it. Circlips in the piston boss retain the hardened and ground gudgeon pin and a cover plate inside the dome of the piston prevents oil spray from coming into contact with the hot crown.

TAPPET BLOCK AND CAMSHAFT ASSEMBLY

The camshaft which is forged from 3 per cent nickel steel is cyanide-case-hardened to a depth of 0·060in and gear driven from the flywheel end. The whole assembly can be removed after taking away the side covers and tappet blocks. C.A.V. fuel equipment is fitted and there is a pump for each cylinder to deliver fuel of a viscosity of 70 secs. Redwood No. 1 at 100 deg. Fah., at a pressure of 2200 lb per square inch through a six-hole nozzle. For land engines there is a wet sump lubricating system with an oil pressure pump and a dry sump for the marine unit. Lubricating oil is pressure-fed to all working parts and there is an oil cooler. Engine cooling is effected by circulating soft fresh water through the cylinder water jackets and a "Serck" heat exchanger by means of a gear driven centrifugal pump which has a capacity of 2300 gallons per hour at 1500 r.p.m. To ensure a positive head to the circulating pump and to eliminate possible air locks there is a small overhead balance tank fed by a by-pass. Cooling water to the heat exchanger and oil cooler is circulated by a second gear driven centrifugal pump capable of handling 1900 gallons per hour against a head of 40ft at 1500 r.p.m.

Compressed air at a normal pressure of 250 lb per square inch is admitted to all cylinders for starting up and is under the control of the main handwheel. Three sizes of starting air receivers are supplied, that for the eight cylinder engines having 11¼ cubic feet capacity. The five- and six-cylinder normally aspirated engines and the six-cylinder turbo-charged engine have receivers of 7½ cubic feet, while engines having four cylinders and less are fitted with a 5 cubic feet capacity receiver.

Controls are located on the forward end cover and the direction of engine rotation is clockwise when looking at the control end. The engine is non-reversing and for marine installations power is transmitted to the propeller shaft through an S.L.M. reduction and reverse gear.

ASSEMBLY

The simplification and standardisation of the design has allowed new shop methods of production to be introduced in the shops and have speeded up production, 250 cylinders per month being the present production rate. The interchangeability of components for the different sizes of engine has led to economies in manufacture and greater accuracy while an increased number of machining operations from a common datum has eliminated much fitting work. As reorganised, the erecting shop is so arranged that the engine is assembled in six stages, five of which take place on a length of track, and the

ASSEMBLY OF CRANKCASE AND CYLINDER HOUSING

parts required for each operation are fed from successive sub-assembly bays alongside. On the track the various engines are not grouped in sizes but after the completion of the fifth stage the partly assembled engine is finished upon a unit basis and then passes to the test bay and final painting.

The foundry produces about 35 tons of castings per day, the crankcases and cylinder blocks are painted and allowed to age in the open for six months while it is the company's practice to permit the cylinder liners to rust before being passed through the shops. After its six months of exposure the cylinder block is taken to a triple head milling machine having a work capacity for items 15ft long by 5ft wide by 5ft high. The rough casting is then machined in three operations, half of the bottom face, half of the top face and one side cover face being done, and the casting reversed for the overall machining to be completed and then this is followed by a finishing cut over the top face. The base of the crankcase is machined and acts as a datum for the engine, and a multiple borer, using locating dowels, cuts holes in the end plate gear housing for mounting the water circulating pumps, lubricating oil pumps and control valves for starting and manœuvring. An automatic machine with twelve tools completes the outside machining of centrifugally cast liners which are rough bored internally then honed. After the latter operation the inside surface of the liners is chrome hardened by the "Listard" method, which is essentially an electrical brazing process using 1500 amps. and taking about three hours, and then given a diamond hone finish.

In order to expedite output a three spindle borer has been installed and is used for rough boring the big and small-ends of the connecting-rods. These are finished in a dual-head fine-point borer, using carbide-tipped tools, which ensures close tolerances being maintained in the bores and between centres. By fitting a special adaptor the three spindle borer can be converted to a uni-spindle machine and then used for boring the tappet blocks. Another machine which has horizontal and vertical adjustments has been designed for preparing the various pipe connections ready for fitting to the engine.

At stage one on the assembly line the cylinder block is mounted on a wheeled chassis which runs in a track along the length of the shop. The cylinder heads, which have been water tested to 100 lb per square inch, are placed in position with the valves already fitted and ground in and springs inserted. The rocker gear is not fitted at this point so as to allow the nuts at each cylinder to be evenly tightened without difficulty. At the next stage the camshaft and gearing are mounted, the camshaft having flats milled by a vertical head machine, to take the cams, which are held in position by king pins. The cams are cyanide hardened and set at 18 deg. from top dead centre in the normally aspirated engine and 15 deg. in the turbo-charged unit.

The next components to be added are the rocker arm assembly and the completely assembled tappet block, including air starting, air inlet, fuel pump and exhaust, the contact wheels being hardened to a depth of 0·060in and the plunger pistons to 0·030in. At the fourth stage the cast iron pistons, with a toroidal combustion chamber machined in the crown, and complete with rings, are assembled with the connecting-rods and floating gudgeon pins. Each sub-assembly is fitted into place by means of a special machine and held in position by a clamp. Over the final length of the assembly line the governor gear is fitted, also the air starter manifold and air manifold and the gears are marked so that they can be located directly with the crankshaft drive. The fitting of the cooling water pipes and control valves complete the system and it is tested for a period of one hour at 60 lb per square inch, the pressure being generated by an air-hydro pump.

The completed upper portion of the engine is now lifted from the line and taken to the crankcase, with crankshaft in position, placed ready to receive it and the engine moves towards completion as an individual unit.

Manufacture of Resistance-Welded Steel Tubing in America

CONSIDERABLE recent progress in the production and fabrication of welded steel tubing has been responsible for the widespread use of this material in America, as in Britain, in fields of construction ranging from aircraft frames to hydraulic pressure lines. Compared with seamless tubing, electric weld tubing has the major advantages of concentric inside and outside diameters, freedom from internal and external hot rolling defects and—from a manufacturer's point of view—a much smaller initial tube mill investment, less labour, fuel and maintenance cost, as well as smaller end scrap losses. In general, the cold roll-forming process is suitable for the production of tubular shapes in which the wall thickness ranges from a minimum of 2 per cent to a maximum of 12 per cent of the diameter. Within the basic field of standard tolerances, the cost per ton or foot of electric weld tubing compares favourably with all other tube-making processes.

One of the most recent and productive American mill installations for the manufacture of tubing by the electric resistance welding method is at the Electricweld Tube Division of the Jones and Laughlin Steel Corporation at Oil City, Pennsylvania. It illustrates the latest American practice. This factory produces round tubing within a ¼in O.D. by 22 B.W.G. to 4in O.D. by 10 B.W.G. range and, furthermore, makes a variety of square, rectangular and other non-circular tube shapes. Apart from slitting lines, its major equipment consists of five "Yoder" and one "McKay" mills, all being of the progressive cold roll-forming type. A section of the works, with three of these mills, is illustrated in Fig. 1. The plant has a rated output of 56,000 tons of mechanical

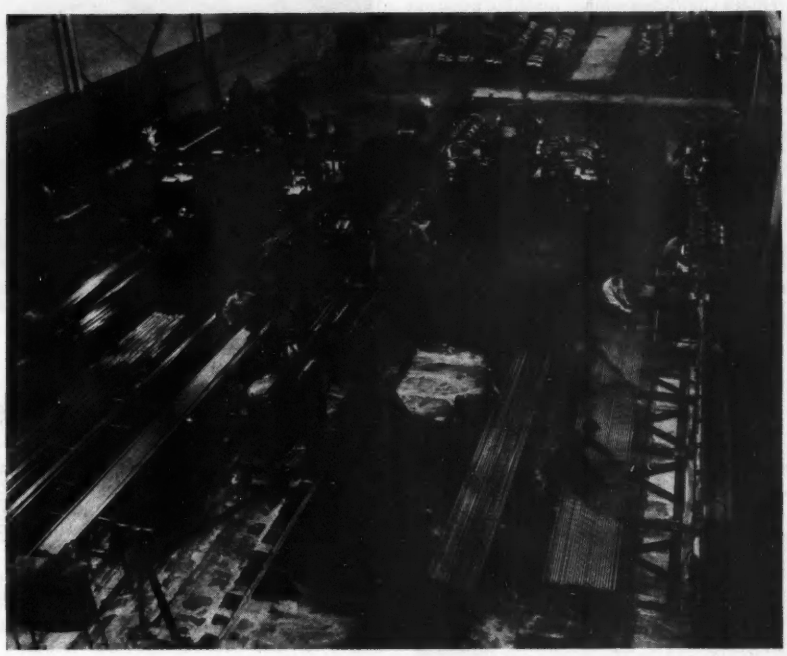


FIG. 1—SECTION OF TUBE WORKS

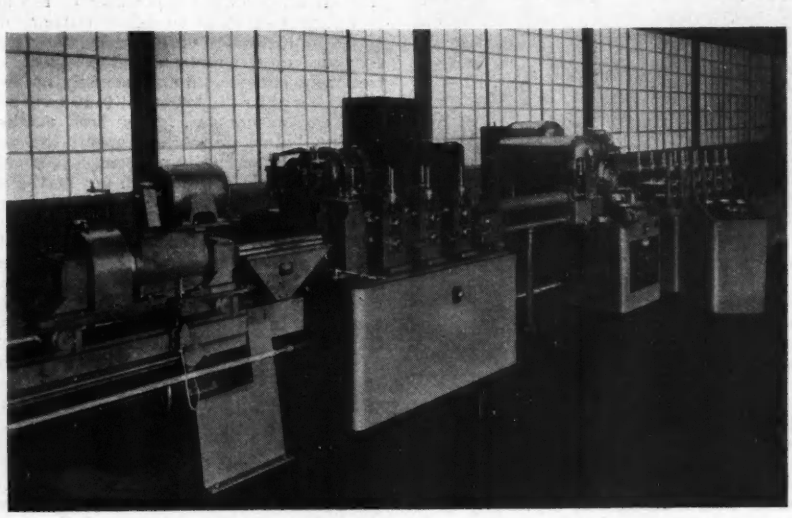


FIG. 2—"ELECTRICWELD" TUBE MILL

tubing per annum. Recently, with only five mills in operation, 11 million feet of tubing were produced in one month, working a three-shift, five-day week.

Mill Lay-Out

Fig. 2 shows the units of a mill for the production of electric weld tubing within a ¼in O.D. by 0·028in to 3in O.D. by 0·134in range, at speeds of up to 150ft per minute. The cold-rolled strip coming from the rolling mills is slit to the exact widths required for the various sizes of tubing, a process which, incidentally, furnishes edges suitable for welding. Subsequently these relatively short (500ft approximately) coils of narrow strip are welded into larger coils (3000ft to 4000ft), which are stored in an area close to the tube mill, from where coil after coil is transferred to the coil box, noticeable at the extreme right of Fig. 2. The strip enters the tube-forming machine adjacent to the coil box and, in sequence, the newly formed tubular section passes through the tube welder, the tube cooling unit and the sizing and straightening machine. It is then automatically cut into the required lengths by a flying cut-off unit, and is inspected, counted and bundled on a run-out table. From here it may pass through end-facing, heat-treating, hydrostatic testing, straightening or cold-drawing operations. Mill adjustments are made on the operator's control cabinet, affecting both the variable speed transmission of the machines and the welding control panels; 180 c/s welding current is supplied to the tube welder from a motor generator set controlled by means of a rotating voltage regulator.

The idler roll storage coil box is able to hold two coils—one in front, supported on ball-bearing idler rolls, for feeding the forming machine; the other directly behind it, resting in a vee-shaped trough. The rear coil is held in reserve, ready to be moved forward just as soon as the trailing end of the front coil leaves the box. The steel plate sides of the coil box are

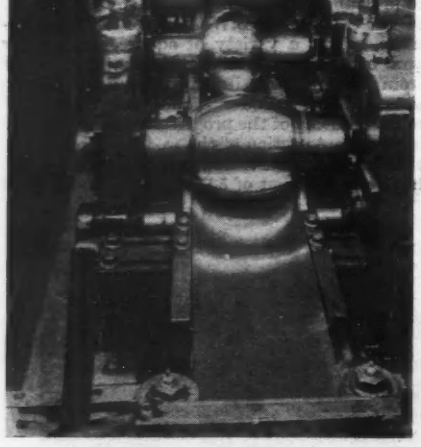


Fig. 3—Passage of Strip through Tube Forming Machine

adjustable laterally in order to hold strip of different widths in alignment with the roll-forming machine.

Tube Forming

Fig. 3 illustrates the passage of the strip through the six successive pairs of forming rolls of the tube-forming machine, each one causing further bending of the initially flat material, until it emerges as a perfectly cylindrical tube with edges butting together. In order to indicate the drive principle adopted for the completely standardised and interchangeable roll stand assemblies, the gearcase cover had been removed from the first roll stand shown in Fig. 4. The machine main drive is transmitted to the worm shafts of the individual roll stands, which are interconnected by roller chain flexible couplings. While the bottom roll obtains its drive directly from the worm gear, a set of toggle-type idler gears is used to drive the top roll, thus permitting

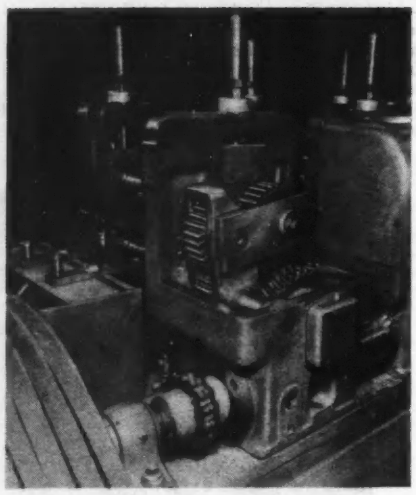


Fig. 4—Roll Stand Gear Drive

maximum roll adjustment while maintaining constant pitch line mesh. Taper roller bearings are used throughout the main roll stand spindle assemblies. Idler roll supports are generally attached in all spaces between roll stands. Each support holds two hardened and ground spindles with anti-friction bearings on which the idler rolls are mounted. Lateral adjustment of these idler rolls is obtained by means of two parallel and horizontal screws.

Tube Welding

As the newly formed tube, with edges butted, leaves the roll-forming machine, it enters the welder. When the open seam passes directly underneath and between the sharp edges of the two electrodes, the butted edges of the tube are instantaneously molten, and a pair of squeeze rolls, mounted on vertical spindles below the electrodes, press the edges together, uniting them by complete fusion into one homogeneous mass of metal which tests have shown to be stronger than the unwelded part of the tube wall. The strength of the weld obtained on mild steel is improved by "pin-pointing" the heat, i.e., concentrating it in a very small area of the weld zone, so that it is quickly absorbed by the adjacent cold metal without raising the temperature of the latter to a degree sufficient to reduce strength or to cause undesirable changes in the micro-structure of the material. Subsequent heat-treatment is therefore not generally necessary. While Bessemer mild steel, of 0·10 to 0·20 per cent carbon content, gives best results in welding, both Bessemer and open-hearth steels up to and beyond 0·40 per cent carbon can be successfully welded, although not at the same speeds as mild steel. Since a considerable quantity of tubing produced by the electric weld process is intended for chromium plating, it requires a surface of high density, a smooth finish free from imperfections, and absence of weld porosity. Much of such chromium-plated tubing is being used in the manufacture of furniture and thus also has to be able to stand severe bending without opening of the welds.

Fig. 5 shows a general view of the tube welder and its control cabinet, the panel of which comprises meters and push-button controls, facilitating one-man operation of the entire tube mill from the most convenient position in front of the welding unit. It will be noticed that bracketed bronze guides are mounted between the welder and the exit end of the forming machine. These guides facilitate passing the leading end of each new coil from the forming machine to the welder. Constructional details of the tube welder are shown in Fig. 6, which shows a sectional elevation through the secondary conductor. Both the inner and outer secondary conductors *X* and *W* are made from high-conductivity copper alloy and are internally water cooled, as indicated by the arrows. The whole secondary end is supported on a heavy-duty roller bearing. The electrodes *U* are high-conductivity copper alloy forgings and are externally water cooled. The rotor assembly comprises a transformer spider, the inner and outer secondary conductors and a primary brush assembly. A heavy-duty, internally water-cooled single-phase welding transformer has combination mica-asbestos insulation and pancake windings. The secondary leads are large area copper pads, securely bolted to the secondary conductor of the rotor assembly. The entire rotor assembly is suspended from a heavy steel frame resting on four large steel screws which turn in bronze nuts for raising and lowering the electrodes in relation to the surface of the tube. These screws are driven through a roller chain from a geared motor attached to the underside of the welder base-plate. The micrometer gauge on the front of the welder (see Fig. 5) aids the operator in controlling the electrode pressure upon the tube surface. For trimming purposes the electrodes are rotated through a roller chain by means of a small geared motor mounted on top of the rotor assembly. The drive is clutch controlled by means of a hand lever situated at the side of the welder.

The electrode trimmer noticeable in the upper right-hand corner of Fig. 5 permits quick and accurate trimming of electrodes without their removal from the welder. Three sizes of arbors with their respective cutters are furnished for trimming electrodes of all sizes within the rated capacity of the mill. The trimmer is raised and lowered by adjusting the vertical feed spindle nut. While trimming, it is

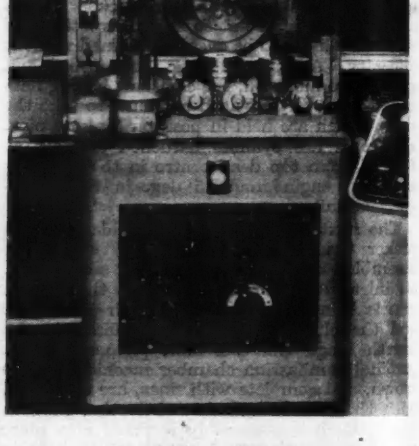


Fig. 5—Tube Welder

turned through an arc between the disc electrodes by means of the crank handle. On entering the tube welder, illustrated in Fig. 5, the tube shell passes along a seam guide blade, a seam guide roll assembly, and a squeeze roll assembly. The seam guide blade holder is fully adjustable for accurate positioning of the tool steel knife blade which guides the butted edges of the tube to the exact centre line between the electrodes. The seam guide roll assembly embodies two seam guide rolls running on spindles which are adjusted laterally by means of a horizontal screw. The squeeze roll assembly comprises a support holding the squeeze roll

spindles which are laterally controlled by means of two micrometer-equipped screws.

In welding, a small amount of molten metal is squeezed from the butted edges of the stock, forming a bead or flash on both the outside and the inside of the seam, which is removed with the aid of three mill auxiliaries illustrated in Fig. 10 : the ironing roll stand *E*, the outside bead removing tool holder *F* and the automatic

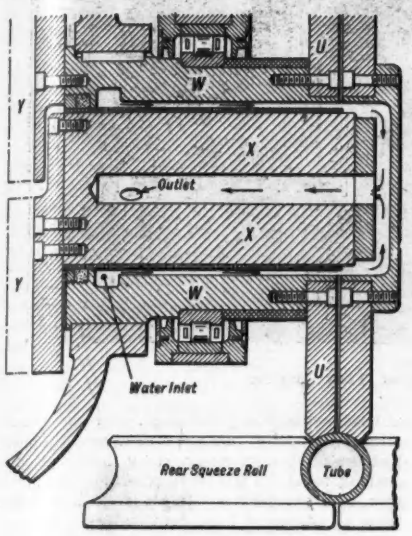


FIG. 6—SECONDARY CONDUCTOR OF TUBE WELDER

bead winder *G*. The ironing roll stand incorporates two horizontal spindles on which the non-driven ironing rolls are mounted. Its position relative to the point of welding is close enough to ensure that the weld passing through the gap between the ironing rolls is still in the plastic state. The outside bead-removing tool is attached to the ironing roll stand and is equipped with a cam-type quick lift and an accurate wedge adjustment. On account of the red heat of the bead to be cut, the tool is usually provided with a cemented carbide tip. The automatic bead winder is driven by a small geared motor through spring-loaded friction discs. This design permits just enough disc slip to keep the reel turning without undue tension on the bead, thus reducing the likelihood of bead breakage to a minimum. The motor control is interlocked with the welder control, providing automatic winding operation synchronised with the starting and stopping of the welder.

Except for such specialised applications as telescopic tubing, there is generally no great need to remove the considerably smaller inside flash. Tube standards require that the maximum height of the inside flash will not exceed the wall thickness or, in any case, not exceed $\frac{1}{16}$in. Similarly, if inside flash removal is specified, its maximum permissible height is 0·010in. Fig. 3 illustrates a case of a mill producing an "inside flash removed" grade of tubing; an internal plug is supported on a mandrel rod from a bracket mounted between No. 4 and No. 5 roll stands. The size of this internal plug determines the tube internal diameter, since it is situated at a point close to the welder where the ironing rolls are able to roll out the still plastic excess material over the mandrel plug, so that an almost circular bore is established. Alternatively, an internal cutter may be mounted at the end of the same mandrel rod, designed to remove the internal flash in a manner much like the cutting action of the external tool. Such an arrangement, however, calls for special means of removing the cuttings collecting within the bore of the tube.

COOLING, SIZING AND STRAIGHTENING

The tube coming from the welder passes through a cylinder, where it is rapidly cooled by a series of water curtains descending through slots cut transversely through the upper part of the cylinder. It then is fed through the sizing and straightening unit, which is illustrated in Fig. 7. An important function of this unit is to exert pressure from the sides of the tube in order to restore it to approximate roundness after it has been slightly flattened in a horizontal direction by passing through the ironing rolls just behind the point of welding. The tube, as initially formed, is made slightly oversize, so that by means of all-round pressure applied by the sizing rolls it may be reduced to the exact diameter required. For example, a 2in O.D. mild steel tube of 12 or 14-gauge wall thickness is about 0·015in to 0·020in oversize when leaving the welding unit, and is brought

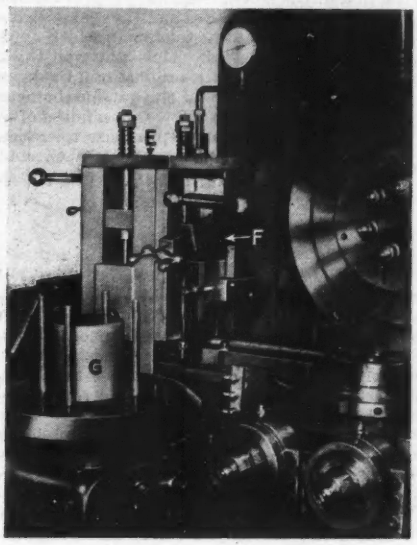


FIG. 10—TUBE WELDER AUXILIARIES

down to the 2in O.D. in the sizing rolls. By lining up the sizing rolls with a cluster of small rolls mounted at the exit end of the mill, known as the "Turk's Head," the tube is simultaneously straightened. The "Turk's Head" is adjustable in all directions, so that it may be set to counteract any tendency of the tube to curve upwards, downwards or sideways. Equipped with a special set of reshaping rolls at its exit end, the "Turk's Head" may also

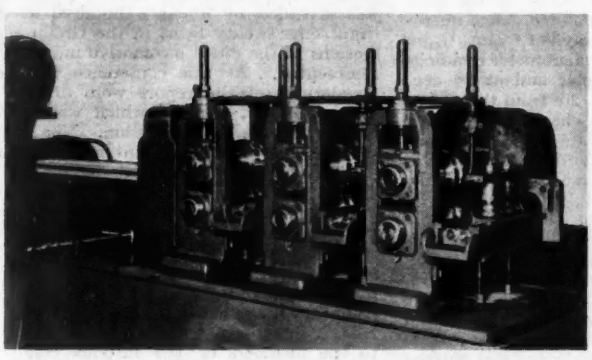


FIG. 7—SIZING AND STRAIGHTENING UNIT

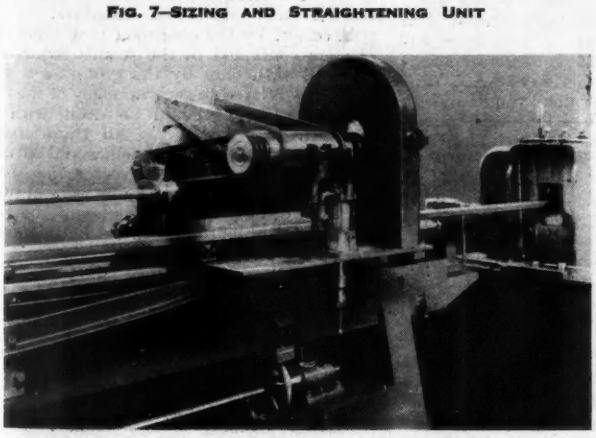


FIG. 8—CIRCULAR SAW FLYING CUT-OFF MACHINE

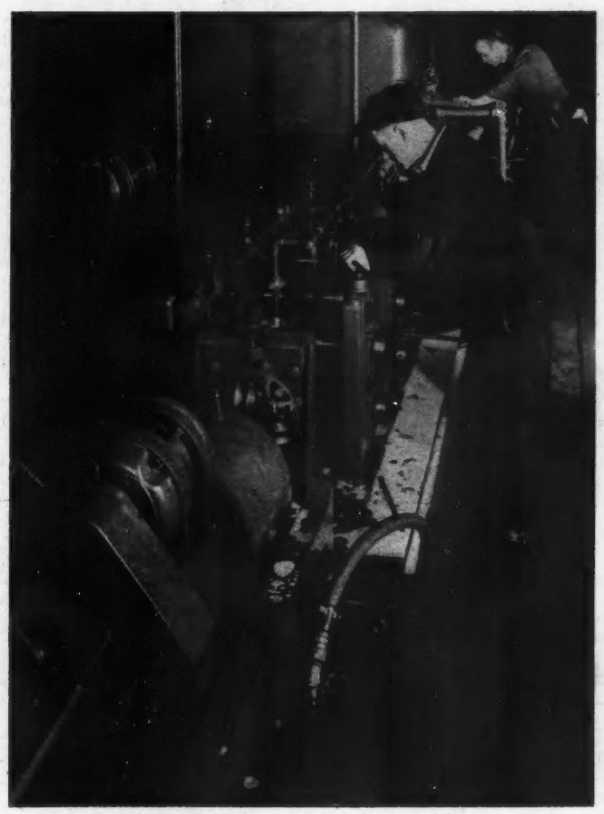


FIG. 9—LATHE TOOL FLYING CUT-OFF MACHINE

be used to convert round tubes into square, rectangular and other non-circular shapes.

The speed of the sizing and straightening unit is synchronised with that of the tube-forming machine through a common drive. In turn, the speed of both these machines controls the welding speed, all the rolls on the welder being idlers, with the driven rolls on the former two units providing the necessary traction of the stock, from flat strip to finished tube. The wall thickness and the diameter can be held within the same tolerances which apply to the strip stock used. Thus, the wall thickness will come within the original mill thickness tolerance of the strip and the outside diameter will be accurate within a few thousandths of an inch. The following are typical size tolerances applicable to a 1in O.D. by 16 B.W.G. cold-rolled standard tube :—O.D., ±0·004in ; I.D., ±0·005in ; ovality, 0·005in.

Cutting Off

The finished tube leaving the tube mill enters the flying cut-off machine which may be set to cut the tube " on the fly " to any desired length from 4ft up, without stopping or reducing the speed of the tube mill. There are four different types of cut-off machines in use at present. The first of these is the rotary disc machine equipped with small disc wheel cutters of the kind used by plumbers, preferred because of the relatively long life of the cutters. The action of the cutting disc creates an inward pressure, which causes the ends of the tubes to be pressed in about $\frac{1}{16}$in so that subsequent reaming may become necessary. The straightest and cleanest cut is made by a similar machine, equipped with lathe cutting tools, which is illustrated in Fig. 9. Comparatively rapid wear of the cutting edges means frequent mill stoppage for tool replacements. Generally, this type of cut-off is used only on heavier wall tubes and for special requirements. In cutting, a slight burr is thrown up, both on the inside and the outside.

The third kind of machine (Fig. 8) utilises a saw cut at high speed. In making the cut the tube is sometimes distorted due to the pressure of the saw, and a pronounced burr is thrown up

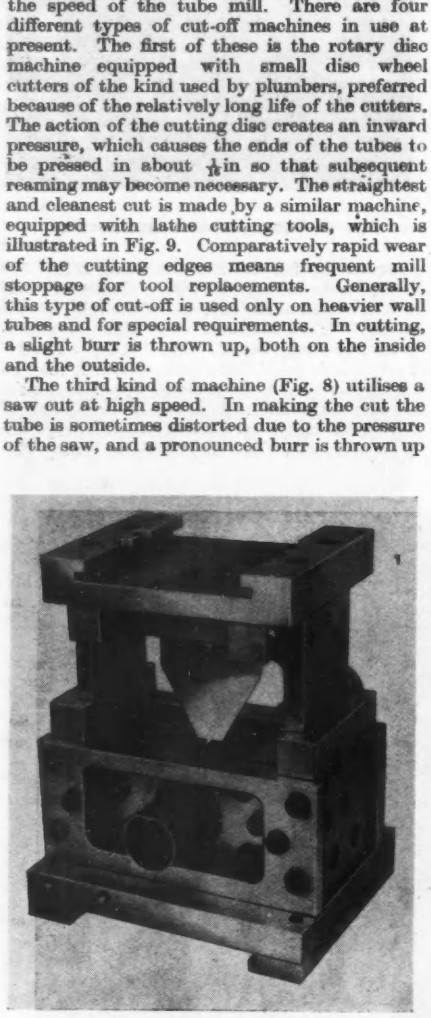


Fig. 11—Punch Cut Shear

on both the outside and inside. A deburring machine is therefore often used in conjunction with a saw cut-off. This saw cut machine is employed to cut square, rectangular and other non-circular tube shapes. The simplest and most economical device, however, is the punch cut shear, which is shown in Fig. 11. It is preferred wherever it will serve the purpose and is available in several sizes, the largest of which will cut tubing up to 2in O.D. The cutter blades, generally, wear well and make a clean cut, without noticeable burr, but the end of the tube suffers a small indentation where the pointed tip of the cutter first comes in contact with it.

Fig. 12—Hydrostatic Test Bench

The following cutter length tolerances apply to all electric weld tubing manufactured by the company :—

Type of cut	*Length*	*Tolerance + or −*
Lathe cut	10ft to 20ft	$\frac{1}{16}$in
	20ft to 30ft	$\frac{1}{8}$in
Punch, disc or saw cut	3ft to 12ft	$\frac{1}{32}$in
	12ft to 20ft	$\frac{1}{16}$in
	20ft to 30ft	$\frac{1}{8}$in

Inspection and Heat-Treatment

Each mill delivers its tubing to a runout table where it is tested for proper size and length and where its surface condition and weld quality is inspected. The outside diameter is measured by means of a micrometer or, on light-wall tubing, a ring gauge in order to prevent distortion. The inside diameter is measured by means of a plug gauge ; a slotted plug being used if the flash has not been removed. In accordance with tube standards, measurement of the wall thickness or gauge of the tube requires the use of a ball-pointed gauge micrometer having a radius of anvil of $^{5}/_{32}$in $\pm^{1}/_{64}$in. Ovality is measured by micrometer readings taken at maximum diameter and at 90 deg. from this position, at least 2in from the end of the tube. Straightness is checked by placing the tube on a surface plate with both ends touching the plate and measuring the maximum deflection with a feeler gauge. For lengths under 1ft the maximum tolerance is 0·010in; over 1ft, 0·010in per foot of length. To a certain extent hydrostatic testing of tubes is performed on special test stands (Fig. 12) by forcing water into the tube at high pressure. In order to ensure that the tubing has the required physical properties it is subjected to a variety of tests at regular intervals. It is expanded, flared, flanged, flattened and crushed endwise to determine the quality of the weld. The bulk of commercial tubing produced is in accordance with S.A.E. 1010 to 1020 specification, while some structural and aircraft applications may involve materials in the S.A.E. 1025 to 1040 range. Depending upon requirements, the temper within certain high limits is obtained by rolling the steel to given Rockwell or Brinell specifications or by cold working the tube by swaging or drawing. The fact that cold drawing, either with or without an inside mandrel, is commonly performed is further evidence of the uniform soundness and general excellence of the welded tube. If soft tempers are needed or if cold forming stresses are to be relieved, tubes are heat-treated by passage through a controlled-atmosphere annealing furnace.

Scrap Losses

In the resistance welding process, when using coiled strip in lengths above 500ft, the metal is so uniform in thickness and the welds are so strong from the beginning to the end of the coil that end cropping is reduced to an almost negligible percentage. In the various automatic cut-off machines discussed the metal lost is merely that removed by their respective cutting tools. Thus it is possible for mills of this kind to operate with an overall scrap loss from all causes of 3 per cent or less.

Diesel Locomotive Productivity Conference

At a luncheon in London, in December last, of the Internal Combustion Group of the Locomotive Manufacturers' Association of Great Britain it was announced that action had started on the report of the Diesel Locomotive Industry Productivity Team. Since that date a large amount of work has been done by committees and sub-committees in the further discussion of the report and many of the recommendations are under active consideration. A conference held at Blackpool recently was attended by about a hundred delegates from some twenty firms in the Group and all sections of the diesel locomotive industry were represented. At this conference the recommendations of the report were divided into seven subjects, each of which was allocated to a syndicate for discussion. The subjects selected for discussion were market research and sales organisation, designing for productivity, organising for productivity, costing and accounting, management, labour and workshop control and techniques. Each of the syndicates discussed fully the recommendations made in the productivity team's report and placed its comments before the conference for endorsement. During the conference the L.M.A. director noted all points for reference to the members of the internal combustion group at a general meeting, and those for discussion with individual members. It was pointed out by the chairman that some of the matters contained in the team's report could be dealt with only by the group as a whole, since they related to general policy of the industry, while others could be dealt with only by individual members. All those matters, in whichever category they fell, would be tackled appropriately. Indeed, a great many of them had been dealt with already or were in process of being dealt with, and copies of the report of the team would be regarded by members as a current reference book.

The Fairey "Gannet."—The Fairey Aviation Company announces that the naval anti-submarine aircraft, hitherto known as the Fairey 17, has been named the Fairey "Gannet." The three-seat "Gannet," which has been ordered in quantity for service with the Royal Navy, is powered by an Armstrong Siddeley Double Mamba propeller-turbine, and is extensively equipped for submarine detection and destruction.

Joint Engineering Conference

No. IV—*(Continued from page 838, June 22nd)*

WE conclude this week, summaries of the papers presented at the Joint Engineering Conference which ended on Friday, June 15th.

Thursday, June 14th

SOME CONSIDERATIONS ON THE WATER SUPPLY TO TOWNS, WITH SPECIAL REFERENCE TO CONSUMPTION AND WASTE

By H. F. CRONIN, C.B.E., Vice-President I.C.E., M.I.Mech.E.

The Royal Commission of 1844 revealed a dreadful state of affairs in the crowded dwellings of the poor in large towns. Close to the densely packed houses were numbers of privies and pigsties, tubs full of hogwash and heaps of offensive manure, in the midst of which often stood a pump for the water supply of the inhabitants, to which contaminated water was often admitted. The final report of this Commission contained a number of recommendations on drainage and water supply, embodied in the 1847 Waterworks Clauses Act.

During the last century the water engineer has carried out magnificent works which have made a signal contribution to the health and well-being of his fellows. In the 1850s Manchester, Liverpool and Glasgow inaugurated schemes for bringing water to those cities from a considerable distance. The water for Manchester was obtained by building reservoirs in the Longdendale Valley about 18 miles away; Liverpool went to Rivington, whence the water was conveyed to the city through an aqueduct 17½ miles long, in 1857. Glasgow obtained its supply from Loch Katrine, 34 miles from the city, in 1859. Yet the growing demands of expanding industry and population compelled Manchester, Liverpool and Birmingham to seek supplies still further afield, involving aqueducts of 96, 68 and 73 miles in length respectively. Liverpool built the magnificent Vyrnwy dam in 1880, creating a gigantic lake to hold 13,000 million gallons of water. Birming, by an Act of 1892, was able to use water from the Elan and the Claerwen. Three dams were built on the former, and the construction of a large dam on the latter is now proceeding.

Great Britain is very fortunate in having vast supplies of underground water in many areas where surface supplies are insufficient. Although an expert knowledge of geology is the best guide to a selection of sites for wells, Mr. Cronin points out that electrical methods are now used successfully for water exploration. He refers to various methods of filtration, the most recent development being a self-cleaning screen in which water is strained through a stainless steel gauze having more than 70,000 apertures to the square inch.

He states that plenty of water is still available in isolated areas, but that the cost of conveying it prevents its use. For example, the cost of an aqueduct from Mid-Wales to London to carry about 150 million gallons a day would be about £50 million. He proposes the very interesting idea of combining a large water and electricity scheme, the electrical energy generated by the water being used to pump water through the aqueduct and thus reduce its cost.

A CENTURY OF ENGINEERING PROGRESS IN BRITISH COAL MINES (1851–1951)

By B. L. METCALF, M.I.Mech.E.

By 1850 the problems of pumping in the mines had been overcome by the early inventions of Savery, Newcomen and Watt, and steam power was available on a general scale. The introduction of coal smelting in the latter half of the eighteenth century had brought down the price of iron and had given an enormous impetus to the application of machinery built to the designs of these early pioneers, and others such as Trevithick and Smeaton. The most serious problem facing the engineer was ventilation and many accidents occurred due to the explosion of firedamp, particularly where only one shaft was used, and after the disaster at New Hartley colliery in 1862, when 201 lives were lost, legislation made two shafts obligatory.

It is interesting to speculate on the kind of paper which will be presented to a similar conference in 2051. The author may have to record that, although the output of coal was well maintained throughout the last half of the twentieth century, from then on it began to show a steady decline owing to the establishment of atomic piles throughout the length and breadth of the land. Nevertheless, pits are being planned to-day to last fifty years and some will last very much longer than that. Emphasis in the future will be on the improvement in the output per man-shift on the one hand, and in the safety of the men on the other hand, and these two improvements must be reconciled and progress must run on parallel lines.

In considering some of the trends in development the most noticeable change will be the improvement in surface lay-out. No longer will a colliery surface look like a muddle of uncorrelated buildings as can still be seen at many collieries. Pit-head baths, washeries, colliery offices, winder houses, substations, workshops, ambulance room, lamp room and covered walking ways between the lamp room and headgear will all be designed to harmonise with each other with a functional unity seldom achieved in the past. At existing collieries which have to be modernised and reconstructed to increase output, it will not be possible to achieve the same pleasing result, but a great deal of attention will be paid to the surface lay-out to maintain a smooth and efficient flow of men and material. In introducing new machinery, the impact on the men must be carefully studied.

THE DEVELOPMENT AND USE OF GAS-PRESSURE CABLES FOR HIGH-VOLTAGE SYSTEMS IN GREAT BRITAIN

By S. E. GOODALL, M.I.E.E., and D. B. IRVING, M.I.E.E.

The first experimental installation using high gas pressure to suppress ionisation, or the reaction involving recombination of ions, passed satisfactory tests in November, 1931, and the first commercial installation in the world was completed in England in the following year to the order of the Central Electricity Board; the cable, 2½ miles long, was laid between Hackney and Walthamstow. It operated at 66kV and has given satisfactory service ever since, even under severe conditions of bombing during World War II.

There are two basic designs of sealing end in use for gas-pressure cables, one in which porcelain resists the gas pressure, and the other which incorporates a synthetic resin bonded paper or porcelain internal pressure-retaining tube. One of the special problems is to ensure that the joint between the sealing end and the cable is gastight. Some mechanical difficulty has been presented by this in the past, but in the latest designs this has now been overcome by the use of properly designed flanged joints, known as the controlled compression type.

At certain feed points high-pressure gas cylinders are installed and connected to the cable system by means of reducing valves. Associated gauges show readings of the pressures in the cylinders and in the cable system. Remote indication is immediately given of a fall in gas pressure indicating a leak in the system, which in time would cause a serious loss of gas from the cable. Suitable valve arrangements are also incorporated so that check tests may be carried out by operating personnel.

In Great Britain there is very close technical collaboration between the cable makers, and this has been of great value to the industry as a whole in that it is being found possible by the British Electricity Authority and the Area Boards to secure a considerable measure of standardisation of cable designs and accessories. This work has not yet extended to the gas-pressure cable, except in one or two minor particulars such as the standardisation of porcelain insulators for sealing the ends at high voltages. The authors believe that there is every reason to suppose that when the present work on other types of cable is further advanced, extension into the gas-pressure cable range will be both practicable and desirable.

Friday, June 15th

SEWERAGE AND SEWAGE DISPOSAL: PAST, PRESENT AND FUTURE

By D. M. WATSON, Vice-President I.C.E.

The oldest sewer is one believed to have been built by the Romans 2000 years ago, and can be seen in places many feet below the streets of Jerusalem. At the beginning of the nineteenth century land irrigation was still the reliable and common method of treatment, but when new methods of sewage disposal did come in, they were applied in great numbers and on a vast scale; no less than 454 patents were taken out for processes of sewage treatment before 1886. Major developments which gradually emerged were: humus tanks to arrest finely divided solids discharged by the filters, digestion of sludge, and collection of the gas given off by it. A milestone in the history of sewage purification was the appointment of the Royal Commission on Sewage Disposal in 1898, which issued nine reports in seventeen years. During that time the bacteria bed became firmly established, and the Commission heard evidence from a vast number of experts, including bacteriologists, chemists, doctors, engineers, managers and physicists.

One of the most spectacular schemes of recent years is the Mogden plant of the West Middlesex Main Drainage, which treats the sewage of a population of 1,250,000 people. In 1946 details were published of the operating results over a period of ten years, from which it is clear that the high standard achieved warranted the large capital outlay involved.

Mr. Watson states that well-designed and well-operated modern sewage works are less likely to cause offence by smell than was formerly the case, many operations being known to have removed causes of complaint. For instance, tanks need not be emptied for cleaning so that sludge lies exposed on the floors; tank effluent need not be sprayed over filters so as to agitate it and encourage the liberation of offensive smells. It is known that lack of oxygen is one of the chief causes of smell from sewage at all stages of conveyance and purification, and that organic solids, even in small quantities, may cause smells. Mr. Watson claims that cleanliness is very important in controlling the smells of a sewage plant.

Most modern sewage works owe everything to experience gained on existing works, to pioneer work carried out at the expense of ratepayers in other places, and to public funds invested for the benefit of those new works. Mr. Watson suggests that modern works should be operated in such a way that maximum experience is obtained from which others can benefit.

MECHANICAL ENGINEERING IN THE IRON AND STEEL INDUSTRY

By W. F. CARTWRIGHT, M.I.Mech.E.

Very little mechanical engineering was employed even in the manufacture of pig iron until the development of an effective steam engine by James Watt in 1775. At the end of the last century there was at Dowlais a blower operating at a steam pressure of 100 lb per square inch with steam cylinders 36in by 64in and blowing cylinders of 88in diameter. About the year 1914 a large German blast-furnace plant at Hamborn was constructed with thirty-seven gas engines in one house. In 1900 the charging of blast-furnaces became a limiting factor in speed of production. The first ste

was the use of some form of lift for the barrows, and this was followed by the principle of the skip hoist, a method which is still widely used.

Handling of raw materials to and from the furnace has been responsible for many major engineering problems. Unloading of ore ships, dumping of iron ore wagons, and handling of molten iron and molten slag have resulted in many ingenious developments. The Hulett ore unloader is a striking example, an enormous piece of mechanical engineering equipment only suitable for the special ore ships of the Great Lakes; there are sixty-six of these machines at work throughout the world, carrying up to 20 tons of ore in the grab. American railways have progressed to the point where wagons carrying more than 100 tons of ore are used in conjunction with wagon tipplers. The capacity of iron ladles has grown to 200 tons, with an axle load of over 40 tons.

Looking to the future, the author states that in the mills the pitch of efficiency has already reached such a high level that there seems but little room for improvement except in detail, although in wide strip manufacture he thinks a continuous cold mill should soon be constructed in which the coils are changed without stopping the mill. Several continuous annealing furnaces have been built for the tinplate industry, and it seems highly likely that this principle will be extended eventually to sheets. The iron and steel engineers of to-day are more fully aware of what is going on in other industries than they were in the past, and they do not hesitate to adapt techniques from these to their own industry, so that it can be expected that iron and steel works of the future will be more refined than in the past and that they will make use of every possible development in mechanical engineering, such as special hydraulic applications and higher steam pressures.

A Multiple Welded Pipeline

SOME interesting work involving the construction of a multiple welded pipe-line about 10 miles in length has recently been completed by Munro and Miller, Ltd., of Edinburgh. The pipe-lines pass under a river in a tunnel about a third of a mile long, and consist of four 4in and one 10in bore pipes, connecting two industrial plants with a further 10in pipe-line from the river side. In addition to these lines the tunnel also carries one 10in, one 8in and eight 4in pipe-lines, to bring the total number of pipe-lines in the tunnel to one 8in, two 10in and twelve 4in, as can be seen from the accompanying illustration. To ensure reliability of the completed work, every pipe weld in the tunnel was radiographed, as well as every positional weld in the overland lines, after which the 4in lines were tested to 750 lb per square inch and the 10in lines to 500 lb per square inch.

PIPELINES IN TUNNEL

The overland pipes were sheathed in bitumen and delivered in approximately 20ft lengths with prepared ends. The dimensions of the pipes were 4½in outside diameter by ¼in thick, 9⅝in outside diameter by ¼in thick, and 10¾in outside diameter by $^{5}/_{32}$in thick, with all ends chamfered for butt-welding at 35½ deg. and a root face of $\frac{1}{16}$in. The lines are supported on concrete plinths 12in high, with steel slipper plates fitted between the pipes and the concrete bearers. All welding was carried out from d.c. mobile welding units; the electrode sizes are given in the accompanying table.

Before doing any production welds, each welder had to submit a sample 4in and 10in butt weld, from which four strips of each weld were cut out and then bend tested, two strips with the root of the weld in tension and two with the root in compression. Two in every hundred of the welder's production welds were completely cut out of the line and subsequently bend-tested to ensure that he was maintaining a high degree of efficiency.

In laying the overland lines six lengths of pipe were first clamped together with welding alignment clamps. A gap of $\frac{1}{16}$in was left between the root faces of the pipe ends, to enable a full penetration to be made with the first run of welding. The five joints were then made by roll or downhand welds, carried out by mounting the lengths of pipe on rollers. The length of pipe thus formed was then pulled into position and a positional weld made to the preceding length. In all positional welds the first or penetrating run was an oxy-acetylene gas run and subsequent runs were by the metallic arc process.

Throughout the overland lines horizontal "U" expansion loops were placed at intervals. The method of erection was to work from each loop, which was at a fixed position or a change in direction of the line, thus leaving one closing length of pipe to be cut to size between each pair of fixed points. The overland lines were run in three sections of approximately 2 to 3 miles, to enable one section to be tested before the completion of the next. After each section had been tested and passed the connecting pipes between the sections were welded into position and the line as a whole was again tested. When the tests were complete each weld was covered with bitumen.

The testing was carried out by filling the line with compressed air to the required test pressure and adding a certain quantity of methylene dichloride gradually to the delivery side of the compressor. Each weld was covered by a rubber clamp, which completely encased it, so that any leak of vapour would accumulate in the muff or clamp. A leak detector, run off a mobile generator, was then used and a probe or nozzle of this detector inserted for a few seconds into each clamp. If there had been any leakage of vapour an audible and visual warning would have been given. In the complete overland pipe-line, excluding the tunnel, approximately 11 miles of 10¾in outside diameter tubing was laid and 32 miles of 4½in outside diameter tubing, 2904 10¾in outside diameter welds were made and 8450 4½in outside diameter welds, and 1000 10¾in radiographs and 2000 4½in radiographs were taken.

WELDING PIPES AT FOOT OF TUNNEL SHAFT

Electrode Sizes

Pipe size, outside dia., in	Overland Pipes			Tunnel Pipes			
	1st run	2nd run	3rd run	1st run	2nd run	3rd run	4th run
10¾	12	10	10	12	12	10	—
9⅝	—	—	—	12	10	8	8
4½	12	10	10	12	12	10	—

The River Crossing

The tunnel under the river is approximately 9ft in diameter and is lined with bolted cast iron segments. It is one-third of a mile long and has a shaft 100ft deep at each of the river banks. The space available at the foot of each shaft was not very great; nevertheless, the bulk of the pipework erection had to be done at one of these points, as may be seen from the accompanying illustrations, showing the welding and testing of the joints in progress. On completion of the tunnel the lengths of pipe were lowered down the shaft and placed in the pipe supports along the length of the tunnel. Two hydraulic turning machines were positioned at the foot of the shaft, with an

X-ray unit, fed from a generator at ground level. The work was arranged so that every joint was made by a downhand roll weld. This work was done at the base of the south shaft and every weld was X-rayed. There were two welders working, one at each side of the tunnel shaft, and prior to welding two pipes were aligned and clamped in position. The 10in and 8in pipes were turned by the hydraulic turning machine and the 4in pipes by hand. After each weld had been completed it was X-rayed and before anything further was done the X-ray print was developed at the top of the shaft, and carefully inspected for penetration, slag inclusion, gas pockets, &c. Having ascertained that the weld was satisfactory the line of pipe was hauled through the tunnel by a winch, as shown in the first illustration. Then the next length of pipe was clamped to the end and the sequence of operations repeated, so that eventually one-third of a mile of 10in tubing was turned at one end by

X-RAY EXAMINATION OF WELDS

hydraulic machine and the same length of 4in tubing turned by hand, using two 6ft levers clamped to the pipe. On completion of the tunnel pipework all the lines were tested by the leak detector to the same pressure as the overland pipes. Slipper plates were fitted between pipes and supports, with one anchor point midway through the tunnel, thereby leaving the shaft pipework floating. In the tunnel 184 10in, 1141 4in and eighty-seven 8in welds were made, all of which were radiographed. Some details of the radiography are given in the table below.

Focus of X-ray unit on 4in pipe	29in
Voltage used in radiography of 4in and 10in pipe welds	110kV
Current used (both 4in and 10in pipe welds)	10mA
Exposure time for 4in pipe welds	1½ min
Exposure time for 10in pipe welds	4 min
Developing time at 68 deg. Fah.	About 6 min

Three exposures of each weld were taken, using the "double wall" technique, one on the vertical and the other two exposures each at 60 deg. from the vertical. By the "double wall" technique is meant an exposure from the outside of the pipe and slightly at an angle, so that the resultant radiograph shows the full weld in the form of an ellipse.

The company for whom the work was carried out supplied the pipes and carried out all testing with the exception of the X-ray examination, which was carried out jointly by the contractor and the company. The placing of pipes in position and all welding and coating of joints with bitumen was carried out by the contractors, Munro and Miller, Ltd., to whom acknowledgments are made.

Protection of Mild Steel Against High Temperatures

An interesting report has been issued by the North Thames Gas Board on investigations into a refractory enamel used for the protection of mild steel against the effects of high temperatures. This report points out that unprotected mild steel is not suitable for long periods of use in an oxidising atmosphere at temperatures above 500 deg. Cent. It has hitherto been necessary to resort to heat-resisting steel in cases where a material having the mechanical properties of mild steel is to be used at temperatures much in excess of that figure. As the cost of heat-resisting steel is about twelve times that of mild steel and the fabrication of articles from heat-resisting steel is usually considerably more difficult than from mild steel, the resulting article is much more expensive.

During the war a method of up-grading mild steel was developed and used with success for the protection of the mild steel exhaust pipes fitted to the Rolls-Royce engines of "Spitfire" and "Mosquito" aircraft. Since the war the process has been improved and several applications, which may be of interest to the gas industry, are mentioned in the report.

A finish of the type in question, known as "Stoneclad," was developed by Matthews Refractories, Ltd., Paisley Works, Swains Road, London, S.W.17, and is applied by Stewart and Gray, Ltd., of the same address. It is designed to protect mild steel or cast iron from corrosion at high temperatures and to permit their use in many instances where heat-resisting steel would otherwise be called for; an exception is where the high temperature is accompanied by considerable stress. It consists in carrying, in a boro-silicate matrix, a suspension of insoluble refractories and bonding it to the metal surface by fusion at about 800 deg. Cent. The treatment may be a single homogeneous coat approximately 0·004in thick where resistance to oxidation only is required, or it may be in two coats, the upper being more refractory than the lower, porous, and 0·020in to 0·060in thick. The properties of the coating depend on the proportions of refractory to matrix, the particle size, the number of layers present and the porosity of the upper face. It is always non-porous at the metal interface. The process has been applied successfully to the emitting surface of black emitter radiant heaters both of those used for space heating and for industrial heating processes.

In tests described in the report, a heater having the panel and baffle plate protected by this process operated for a period of 5000 hours at a panel temperature of approximately 850 deg. Fah. (454 deg. Cent.), at which the baffle plate temperature was about 620 deg. Cent.; on occasions, however, the panel temperature was as high as 890 deg. Fah. and the baffle temperature 690 deg. Cent.

The high panel temperature attained in these tests was the result of doubling the normal heat input of the appliance, while the panel was radiating on to the surroundings at approximately room temperature. At the conclusion of this test the baffle plate had buckled a little and there were small patches at several points near the edges, where the refractory surface had broken away. In addition, there were small deposits of a powdery substance on both the baffle plate and panel, but from the general appearance of the protective coating, the baffle plate was still in good condition.

There was no appreciable change in the appearance of the protected baffle plate after heating for 1700 hours and when examined after heating for 5000 hours. This heater is still running under the same conditions and after more than 7000 hours it is still operating satisfactorily. It was found that the emissivity of this finish is, at the temperature involved in the radiant heaters to which it has been applied, of the same order as that of mild steel.

Apart from the above application, it is used on a number of space-heating appliances and a finish similar to that used for the protection of baffle plates has been applied with success to a fabricated mild steel mixing chamber, used in connection with some experiments in which products of combustion at about 800 deg. Cent. passed through a central tube while comparatively cool recirculated gases were fed into the annulus surrounding the tube before being mixed with the hot gases. Under these conditions unprotected mild steel components had a life of but a few hours, whereas the treated mild steel appeared to be in its original condition at the conclusion of the experiments.

The smooth finish as applied to the panels of radiant heaters is claimed to be suitable for use up to a temperature of 670 deg. Cent. and the more refractory finish applied to the baffle plates for temperatures up to 800 deg. Cent.

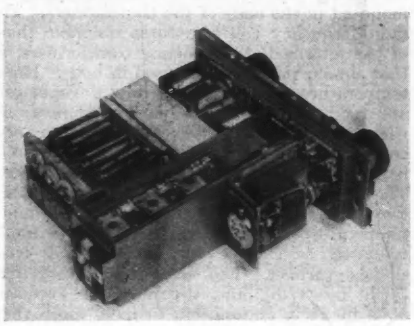
In the conclusion to the report it is stated that the use of this finish has given encouraging results and it is suggested that there may be many instances of high grade heat-resisting steels being used where temperatures of 500 deg.–800 deg. Cent. are encountered, in which mild steel protected by this process would be satisfactory.

American Engineering News

(From our American Correspondent)

A "Subminiature" Low-Frequency Wireless Receiver

A twelve-valve "subminiature" wireless receiver for aircraft use has been developed by Mr. G. Shapiro and his associates of the electronic miniaturisation group of the National Bureau of Standards. This assembly, which is shown in the accompanying engraving, is now regarded as the functional equivalent of a receiving unit more than five times as large which was used during the last war. Because of the growing use of electronic equipment within the limited space of military aircraft and tanks, the Bureau of Aeronautics of the U.S. Department of the Navy initiated at the National Bureau of Standards a broad research



SMALL L.F. WIRELESS RECEIVER

project for "subminiaturisation" of airborne equipment. As part of this project the new low-frequency receiver, in conjunction with a previous high-frequency project (a 60Mc/s, eleven-valve intermediate-frequency amplifier assembly), has been found to cover effectively the communication spectrum. The new equipment, known as a "radio range" receiver, is used to keep aircraft on course and occupies about 55 cubic inches, whereas the volume of the original version was approximately 300 cubic inches. The characteristics of the receiver include continuous tuning from 190 to 550 kc/s, an intermediate frequency of 135 kc/s, and a power output of 100 milliwatts. The twelve valves provide two tuned radio-frequency amplifier stages, a mixer, a local oscillator, two 135-kc/s intermediate-frequency amplifier stages with a band width of about 2 kc/s, a diode detector, an a-v-c diode, a beat-frequency oscillator, an audio amplifier stage,

and a push-pull-parallel power output stage. All stages operate with 26V d.c., applied to the filaments, screens and anodes. Under these conditions of operation four "subminiature" audio power output tubes are required to obtain adequate power output. Unusual problems in the design of the receiver were caused by the need for hermetic sealing of the unit and the high operating temperatures resulting from the very compact construction.

To facilitate mass production, seven detachable subassemblies, each of which can be built independently, are employed in the receiver. The subassemblies are fastened to one another and to the front panel, which takes the place of a chassis. Printed circuits are used to a considerable extent to conserve space and facilitate economical mass production. The wiring is "printed" on steatite or silicone-impregnated fibre-glass. A soldered copper band seals the housing to the front panel; this band can be removed for repair with a key. The air in the unit is replaced with nitrogen before sealing to prevent any possibility of oxidation.

Difficulty was experienced in sealing the bushings of the two shafts projecting from the front panel for control purposes. The solution finally devised made use of commercially available rotary seals of "wobbling-bellows" design. As they were too large to be enclosed in the unit, they were housed in the control knobs, which had to be of conventional size to allow easy manipulation. The tuning of the receiver over its wide operating frequency range created a difficulty: a straight-line tuning characteristic was required, and this could best be attained in the limited space by using a variable-pitch screw to drive slugs in and out of the radio-frequency coils. These screws were produced on a standard lathe fitted with a special linear cam attachment. The tuning slugs were made of the recently developed ferrite base materials, which have been shown to be more stable at high temperatures than powdered iron cores. It was expected that production control of these new materials might present a difficulty; mechanical means were therefore provided in the tuner to compensate for possible non-uniformity of core materials.

The intermediate-frequency transformers have an overall size of ¼in by ¼in by 1¾in. They are double tuned and use permeability-tuned inductors of about 2·8 millihenries. The resonating capacitors are washer shaped and mounted in the ends of the transformers. The radio-frequency coil structures resemble those of the intermediate-frequency transformers, so that similar parts may be used in both. High-temperature tantalum electrolytic capacitors are used for the large-capacity applications. Glass dielectric by-pass capacitors are also employed. Both steatite and silicone-impregnated fibre glass serve as insulating materials. The two audio-frequency transformers and the two line-hash filter chokes employ high-temperature insulating materials and ceramic-insulated wire and are impregnated with silicone varnish. The small size of the panel (5¾in by 1⅞in) and the need for hermetic seals made it undesirable to have more than two external controls. Since one of these was required for tuning, the other had to fill the three distinct functions of gain control, power on-off switch, and beat frequency oscillator on-off switch. All three functions are performed by a special compact switch, designed to be produced entirely by stamping operations. The specially designed miniature gain control uses a high-temperature adhesive tape resistor, also developed by the National Bureau of Standards. The tape is applied around a small glass cylinder, $\frac{5}{16}$in in length and ¼in in diameter, on which 120 axial lines of silver paint have been deposited to form commutator segments. A precious metal brush makes contact with the projecting ends of these silver lines.

Performance of "SEAC" Computer

Since its dedication in June, 1950, the National Bureau of Standards Eastern Automatic Computer—SEAC—(which was the subject of an article in our issue of Feb. 16th, 1951) has solved a large number of important problems and has demonstrated a remarkable reliability in operation. It will be recalled that SEAC was developed and constructed by the National Bureau of Standards under the sponsorship of the Department of the Air Force to provide a high-speed computing service for Air Force Project SCOOP (Scientific Computation of Optimum Programmes), an example of the application of mathematical techniques to large-scale problems of military procurement and administration. SEAC is also available for solving other important problems of general and special scientific and engineering interest. The instrument contains some 11,000 germanium diodes, 800 vacuum valves and 500 pulse transformers. Failure even for a millionth of a second of a single one of these connections and components obviously would result in maloperation of the computer.

To obtain a record of the regular productive computational activity of the instrument, SEAC'S operations were scheduled on a twenty-four hours a day, seven days a week basis during October, November and December, 1950. In general, of the 168 hours of each week, sixteen were reserved for preventive maintenance, while seventy-six hours were allocated to engineering development and testing of new computer equipment. The remaining seventy-six hours were devoted to SEAC'S primary mission, the solution of problems. For the entire three months the "good" time was 76 per cent of the total time assigned to problem solution. Week by week during the period the reliability trend was irregularly upward, with the figure reaching a peak of 96 per cent for the last week. The "good" portion of the time dedicated to problem solution was that in which (1) either problem solutions or coding checks were turned out correctly by the machine, or (2) the machine was in good operating condition but idle. The machine was actually solving problems correctly during more than half of the time assigned to problem solution; coding checks took 17 per cent of the time, and during only about 3 per cent of the assigned time was the machine in order but idle. "Down" time—28 per cent of the total hours allotted to problem solution—was a combination of (1) time lost because of machine maloperation during problem solution, including the time used for re-running of problems, (2) time lost while machine difficulties were being diagnosed and remedied, and (3) time during which the machine was out of order and idle. The computer was producing correct solutions during some 516 hours in the last three months of 1950. Since the machine can add or subtract pairs of fourteen-digit numbers up to 5000 times per second, and multiply or divide them 330 times per second, an enormous number of individual mathematical operations are performed in each functioning hour. SEAC has disposed of a wide range of important problems since its dedication. Air Force problems of a production scheduling nature have received the greater part of the computer's attention. These problems have been reduced to the solution of large systems of linear algebraic equations. Other tasks attacked by the computer concerned such varied matters as electronic circuit design, optical lens calculations, relative abundance of chemical elements, complex mathematical functions, and sorting and tabulating studies for the Social Security Administration and the Bureau of the Census of the United States.

British Coke Ovens for the U.S.

An American contract worth more than 2,800,000 dollars has been obtained by Simon-Carves, Ltd., of Stockport, in the face of considerable competition. The contract is for building in St. Louis a battery of forty coke ovens for the Great Lakes Carbon Corporation, one of the largest American manufacturers of carbon electrodes for steel furnaces. The ovens, which will carbonise almost 500 tons of coal a day for the manufacture of high-grade foundry coke, will be of entirely British design. The work is expected to require twelve months and will be carried out under British supervision.

French Engineering News

(From our French Correspondent)

The car ferry "Kizkulesi," which has been built for service in Turkey, has recently been launched by the Chantiers Dubigeon. It will ply between Istanbul, Pera and Scutari. The vessel is the first of a series of four similar ships having the following main characteristics:—Length, 60m; breadth, 14·58m; moulded depth, 4·8m; deadweight, 350 tons; speed on trial, 12 knots. The ferry will carry both passengers and cars—thirty-eight cars and 700 passengers. Apart from the hull plating, which is riveted, welded construction has been used, employing prefabricated units. The main deck is reinforced to take the weight of the cars. The upper deck, which is reserved for first-class passengers, embodies a saloon with very broad windows all round, a bar buffet, and an electrically equipped kitchen.

* * *

Some interesting details have recently been given by *Le Genie Civil* of the extensive constructional work in progress at Ottmarsheim, on the River Rhine. This work consists of the construction of a large canal, leading from the tail-race of the existing power station at Kembs to a new power station at Ottmarsheim, 14km further downstream. The canal divides into two branches near this power station, one of which will be used for navigation and will lead to locks, and the other for the power station head-race. The canal is 130m in width at water level and 8m deep, the cross-sectional dimensions of the two branches being 185m by 12m and 185m by 23m respectively.

An important problem in the construction of the canal has been to ensure watertightness and to reduce loss of head to a minimum. Various methods of lining the canal have been studied, and an interesting solution has been adopted for those side slopes which are formed by embankments of made ground. Precast slabs have been made by the "vacuum concrete" process, each slab being 7·5m by 3m by 0·09m in size, and weighing about 5 tonnes; 23,000 slabs are required altogether. The programme of works has been carefully arranged to give the high rate of placing required, and details are given in the article of the organisation of the casting yard and the emplacement of the slabs. Some eighty or a hundred slabs are being placed daily, and it is expected that they will all be cast in July and in place by the end of August.

* * *

A washing plant for the treatment of lead and zinc ore has recently been installed at Bou Beker, in East Morocco. The production of this seam has increased considerably over the past five years and in 1950 yielded 40 per cent of the total Moroccan lead production and 75 per cent of Moroccan zinc production. The new plant can treat 2000 tons of ore daily. It is intended to double its capacity in the near future to meet the envisaged increase in production, and the Bou Beker seam will be third among world centres for the extraction of lead and zinc when this work has been completed. Part of the lead ore from Bou Beker is treated at the Oued el Heimer foundry of the Sociétés de Pennaroya et de Zellidja, which in 1950 treated 18,500 tons of ore.

* * *

It is expected that gas produced from Lorraine coal will be available for use in Paris within the next two years as a result of an agreement signed by representatives of the East steel companies, the Lorraine coal mines, the Saar Gas Transport Company, and Gaz de France. The scheme involves laying a high pressure gas main, at a cost of 6 milliard francs, and will require 34,000 tons of steel tubes totalling 600 km in length.

* * *

The nineteenth Aeronautical Salon has recently opened at the Grand Palais in Paris. The various aspects of aviation are all covered by the exhibition, including recent work connected with the medical aspects of high altitude flight. All the nationalised companies and technical air schools are exhibiting, as well as many foreign firms.

Industrial and Labour Notes

The Coal Board's Quarterly Statement

At the beginning of this week, the National Coal Board issued its statistical statement for the first quarter of this year. The total output of coal disposable commercially during the quarter was 49,170,835 tons and colliery profits, together with estimated profits of the Board's ancillaries, are put at £9,268,100. Provision for miners' pensions, profits tax and interest has had to be deducted from that sum, in addition to the cost of coal imported during the quarter, which latter figure is given as £3,500,000. The net profit for the quarter is, therefore, put at £4,733,100, and as the interest payable to the Minister of Fuel and Power is estimated at £3,750,000, there remained at the end of the quarter a surplus of £983,100, compared with £693,204 in the final quarter of 1950, and with a surplus of £5,600,011 in the first quarter of last year.

The statement notes that inland selling prices of coal were increased by 4s. 2d. a ton during February last, and also records that, in the first quarter of this year, total production costs were 2s. 4·5d. per ton higher than in the corresponding quarter of 1950 and 9·7d. a ton higher than in the last quarter. The main increases in production costs resulted from increases in the national minimum wages which were agreed upon in October, 1950 and February 1951, and also from Saturday working at overtime rates which, according to the statement, was much more extensive than in any quarter in 1950. In addition, the prices of materials and depreciation costs continued to rise. Average shift and weekly earnings in the first quarter of this year were 38s. 1d. and £10 4s. 8d. respectively for all workers; 39s. 8d. and £10 14s. for adult male workers, and 47s. 5d. and £11 18s. 11d. for face workers. These average earnings included earnings for Saturday shifts at overtime rates. The total wage bill for the quarter, including holiday pay and allowances in kind, required £81,841,757 or 30s. 8·3d. per ton of saleable coal. The average proceeds of coal sold were 2s. 6·2d. a ton higher than in the last quarter of 1950.

Employment and Earnings in the Steel Industry

The British Iron and Steel Federation has included in the latest issue of its *Monthly Statistical Bulletin* a study of the labour position in the iron and steel industry. It comments on the excellence of labour relations in that industry, pointing out that there has been no major strike or lockout within living memory.

At present there are just over 300,000 workers in the British iron and steel industry, including those employed in ore mining and coke ovens at blast furnaces. Earnings in the industry are among the highest of those recorded in the Ministry of Labour's half-yearly survey of earnings and hours. In October, 1950, when the last such survey was made, the average weekly earnings of adult males in the iron and steel industry were £8 14s. 8d. (the average for all industries investigated by the Ministry was £7 10s. 5d.).

The Federation explains that the wage figures include the earnings of general and maintenance workers as well as those of the process workers, and that the figures of average earnings may be somewhat misleading as they give no indication of the range of earnings covered. The earnings of process workers contain a large incentive or tonnage output element, giving them a direct interest in high outputs. But incentive payments are not limited to process workers. The majority of craftsmen and craftsmen's labourers receive an incentive bonus, so that the interest in higher production performance is widespread. There are, broadly, five methods of wage payment in the British steel industry. They are: straight tonnage basis as applied, for example, to certain production workers in rolling mills and melting shops; time rate plus tonnage bonus for other production workers; hourly rate plus weekly bonus related to shop output for craftsmen; time rate for labourers, &c., and fixed weekly wage for clerks, stocktakers, &c. A survey of labour questions, covering rather more than half the ingot tonnage of the industry, was made recently by the Federation. It revealed that the percentage of workers in the three categories of payment related to output was as follows: straight tonnage basis, 16 per cent; time rate with direct tonnage bonus, 39 per cent; time rate with a bonus based on shop output, 45 per cent.

Engineering Wages

The national committee of the Amalgamated Engineering Union, which has been in session at Brighton, devoted a good deal of time last week to debating resolutions on wages in the engineering industry. During the discussions, recommendations were made for a new wages structure involving increases ranging from £1 to £1 12s. a week.

Last Friday a resolution was passed by the committee that all future wage agreements should be framed in language which could be understood by those responsible for operating them. Criticism was expressed about the manner in which the wages agreement of last November was framed, the resolution "viewing with alarm" the chaos which had resulted in the engineering industry.

The committee reaffirmed the union's claim, put forward recently by the Confederation of Shipbuilding and Engineering Unions, for two weeks' paid holiday. The demand has been made on behalf of all workers in the engineering and shipbuilding industries.

What is a Foreman?

The "Terminology Panel" of the British Institute of Management has been studying the "tangled terminology of the supervisory grades." It suggests in a report, just issued, that greater standardisation of title would increase mutual understanding and enable more effective comparison of functions and rates to be made between various firms and industries.

The foreman's duties, the panel considers, are, first, to convey management policies to the workers and to keep management advised, acting as "the essential link between planning and performance," and secondly, to control labour, the work flow, and quality and quantity of output. The study evidently revealed a complete absence of any standardisation of titles as between different industries, the nature of the job, history or age of the industry, and trade union agreements all being found to affect junior supervisory titles. But the report suggests that there is hope that the terms "foreman" and "charge-hand"—which are widely used—will become more general. The Institute's terminology panel, however, wants to see the process speeded up "so that the position of the foreman could be clarified."

British Overseas Trade

The Trade and Navigation accounts, prepared monthly by the Board of Trade, show that the final figure of the value of exports of United Kingdom goods in May was £229,800,000 which was £27,100,000 above the average for the first four months of this year. About half the increase, the Board of Trade says, was due to higher prices. The index of export prices in May (1950=100) stood at 118, compared with 115 in April. The provisional volume index in May was 178 (1947=100) or two points lower than in April. In the first five months of this year, the volume of exports has been about 4 per cent above the average for last year.

The value of imports in May, £338,000,000—compared with £311,500,000 in April—was partly the result of a further 4 per cent increase in import prices and partly the outcome of a bigger volume of supplies. The volume of imports in May was 6 per cent greater than in April and 11 per cent above the January-April average. The excess of imports over total exports in the first five months of this year was £403,600,000, compared with £347,900,000 for the whole of 1950.

The Board of Trade says that a large part of the increase in the excess of imports has been caused by the deterioration in the terms of trade which, in the first five months of this year, were about 16 per cent worse than the average for 1950. By May the deterioration was as much as 20 per cent. The May figures for imports of materials, however, reflect market prices some two or three months earlier, and the Board suggests that it is unlikely that the rapid rate of deterioration will continue. If export prices continue to increase at the same rate as in the last few months, falls in market prices of some major import commodities since March may be expected to be a stabilising influence on the terms of trade over the next few months.

Iron and Steel Scrap

The Minister of Supply, Mr. Strauss, was asked in Parliament last Monday what steps he was taking "as a matter of urgency" to review the prices paid for collecting iron and steel scrap. In a written reply, the Minister said that the Select Committee on Estimates recommended in its third report that the prices paid for collecting scrap should be reviewed, and he was bringing that recommendation to the notice of the Iron and Steel Corporation of Great Britain. The view which had hitherto prevailed had been that an increase in the price of scrap would not produce any significant additional supplies. The only result would be a corresponding increase in the price of steel. In his opinion, the Minister stated, that view was still correct and no increase was warranted in the present controlled prices, which he considered were reasonable.

Coal Output

Last week, the saleable output of deep-mined coal was 3,961,900 tons, which was about 28,000 tons lower than in the corresponding week of 1950. Output from opencast workings last week was 263,100 tons, so that the total week's production amounted to 4,225,000 tons.

The Ministry of Fuel and Power estimates that 47,500 tons of deep-mined output were lost last week through recognised holidays, and 58,500 tons on account of disputes. In the first twenty-five weeks of this year coal output, deep-mined and opencast, totalled 108,594,600 tons, compared with 105,897,600 tons last year. Coal imports this year have amounted to 1,118,400 tons. Exports and bunkers in the first twenty-four weeks of the year took up 4,667,000 tons, as against 9,263,000 tons in the corresponding period of 1950. Distributed stocks of coal at June 16th totalled 11,703,000 tons, or just over 1,000,000 tons more than on the corresponding date last year.

In the course of a speech at a miners' rally last week-end, the Chancellor of the Exchequer, Mr. Hugh Gaitskell, referred to the rising coal consumption and to the fact that output last year was only about 1,500,000 tons above that of the preceding year. He thought, however, that coal production this year should be "somewhere between 5,000,000 and 10,000,000 tons above last year." The Chancellor went on to emphasise the importance of the export demand, pointing out that Europe was now having to import something like 20,000,000 tons of American coal a year. Yet, he said, European countries, from which we had to buy essential materials, were putting coal in the forefront of their demands to us. Coal was, therefore, an important "bargaining counter" in all our trade agreements.

Notes and Memoranda

Rail and Road

SINGLE-DECKED PUBLIC SERVICE VEHICLES.—The maximum overall length of all four-wheeled, single-decked public service vehicles may, as from June 6th, be 30ft, irrespective of the date of first registration of the vehicle. This is laid down by the Motor Vehicles (Construction and Use) (Amendment) Regulations, 1951, made on May 30th, by the Minister of Transport. It will be recalled that in April, 1950, the Minister made Regulations permitting an overall length of 30ft instead of 27ft 6in for four-wheeled, single-decked public service vehicles registered for the first time on or after June 1, 1950.

ROAD RESEARCH LABORATORY LECTURES.—Lecture courses on "Road Materials and Construction," will be held at the Road Research Laboratory, Harmondsworth, during the autumn and winter of 1951–52. As in previous years, they will deal with the fundamental properties of road materials and their application in modern practice, and will include the results of the most recent research. The courses will cover concrete, tar and bituminous materials and soil mechanics. A special course, of about a week's duration, will be given on Road Traffic and Safety, commencing on February 18, 1952. This course will be held at the Road Research Laboratory (Traffic and Safety Division), Langley Hall, near Slough, and will include the most recent research on the laws of traffic flow, and on factors making for safety in road usage. If sufficient entries are received, a special intensive course will be held for senior officers, from November 26 to November 30, 1951, which will include a survey of the most recent developments in road construction and usage. It is intended for those who require a broad knowledge of the subject and who are unable to attend any of the more detailed courses. A fee of £7 7s. will be charged for each course and will cover tuition and registration fees, and any materials that may be used. The Laboratory does not provide living accommodation for those attending lecture courses but a list of hotels will be furnished on request. Forms of application can be obtained from the Director, Road Research Laboratory, Harmondsworth, West Drayton, Middlesex.

Air and Water

THE "BRABAZON" AIRCRAFT.—A written Parliamentary reply by the Minister of Supply says that the "Brabazon I" has already qualified for a special category certificate of airworthiness to allow experimental flying and demonstration. It is hoped that this will shortly be extended to cover the carrying of non-fare-paying passengers. Much development work remains to be done before a full certificate of airworthiness for commercial service could be obtained, or before the aircraft could be used for trooping.

Miscellanea

WELDING DESIGN AND ENGINEERING.—A summer school on "Welding Design and Engineering," arranged by the British Welding Research Association, has recently been concluded at Ashorne Hill, near Leamington Spa. The syllabus included sixty-three lectures, seven discussions and approximately eight hours of film display. The attendance at the school numbered 220 and included representatives from Holland, Belgium and Norway.

SWEDEN'S ELECTRICITY CHARGES.—According to *The Anglo-Swedish Review*, the Swedish Water Power Board has decided to increase the price of electricity by 15 per cent in central Sweden and by 10 per cent in north Sweden. This increase, it is stated, which is due to rising production costs, has been announced at a time when the Government is considering a tax of 10 per cent on electricity. Should the Riksdag pass the tax, prices to the consumer would rise by 20 to 25 per cent.

CHANGE IN "OSRAM" VALVE BASES.—We learn that the General Electric Company, Ltd., is increasing the diameter of the bases of the following types of "Osram" valves from 30mm to 34mm: types X61M, W61, DH63, Z63, H63, L63 and W63. Some types have already been changed and others are being changed in the near future, but the increased size should be borne in mind in connection with screening cans. The new design will eliminate the trouble of bases becoming loose.

BRITISH ELECTRICITY AUTHORITY.—Mr. H. F. Carpenter, F.C.I.S., F.S.A.A., who, as previously announced, is relinquishing his appointment as secretary of the British Electricity Authority upon his retirement in the autumn, has been appointed a member of the committee which has been set up by the Authority to review the organisational and administrative efficiency of the electricity supply industry as it was established under the Electricity Act, 1947, and matters relating to this subject.

THE STORY OF THE BRITISH GAS TURBINE.—A booklet entitled "The Story of the British Gas Turbine" has been produced in connection with the British Gas Turbine Week which was held from June 18th to 23rd. The booklet was compiled by Power Jets (Research and Development) Ltd., with the co-operation of firms in the Gas Turbine industry. It gives a broad picture of the early history of gas turbines, and of particular industrial gas turbine plants now under development in this country.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—Dr. Egon Orowan has been appointed as George Westinghouse Professor of Mechanical Engineering at the Massachusetts Institute of Technology. He joined the faculty of the Institute last June and now succeeds Professor William R. Hawthorne, who has held the Westinghouse chair since 1948. Professor Hawthorne is resigning to accept the post of the Hopkinson and Imperial Chemical Industries Professor of Applied Thermodynamics at Cambridge University.

BRITISH INSTITUTION OF RADIO ENGINEERS CONVENTION.—We learn from the British Institution of Radio Engineers that no further applications can be accepted for tickets for the first two sessions (dealing with electronic instrumentation and valve technology) of the convention on July 3rd to 6th, inclusive. Some tickets for the remaining four sessions to be held at University College, London, are still available from the British Institution of Radio Engineers at 9, Bedford Square, London, W.C.1, but early application is advised.

AMERICAN PRODUCTIVITY TEAM VISIT.—A productivity team from the American pressed metal industry has arrived in this country to discuss mutual problems with representatives of the industry here. The visit is a sequel to that made to the U.S.A. in 1949 by a team from the British pressed metal industry. During its tour the American team will have an opportunity to examine in some detail the British team's recommendations in relation to current problems and to see recent developments in the British pressed metal industry.

DRYING VISCOSE CAPS ON BOTTLES OF RUM.—Infra-red lamp plant, manufactured by the General Electric Company, Ltd., has been installed in the premises of the Proprietors of Hays Wharf, Ltd., to dry viscose caps and gummed labels on bottles of rum. The bottles are carried from the bottling department on a conveyor and pass through the 14ft long infra-red plant in twenty-five seconds, after which they are ready for packing. The plant, which has a loading of 18kW, consists of two vertical opposing rows of lamps mounted in concentrating reflectors, which may be adjusted in height to deal with large or small bottles.

O.E.E.C. TECHNICAL ASSISTANCE PROJECTS.—Three further projects for the improvement of European productivity by means of technical efficiency have been approved by the Organisation for European Economic Co-operation under the technical assistance scheme. Two of these projects involve the dispatch to the United States of expert teams to study, respectively, oil refining and drilling methods and heavy non-ferrous metals fabrication. The third project envisages the establishment of a service for the distribution of technical digests. This brings up to ninety-five the number of technical assistance projects organised by the O.E.E.C.

SUPERVISION AND MATERIALS HANDLING.—The South Staffordshire sections of the Institute of Industrial Supervisors are holding a conference on Saturday, July 7th, at the works of Rubery Owen and Co., Ltd., Darlaston Green, to discuss "Supervision and Materials Handling." The programme will include a tour of the works and an inspection of the materials handling methods in operation. There will also be two lectures, followed by questions and discussion, on "The Foreman's Part in Materials Handling," by Professor J. R. Immer and "Some Aspects of Materials Handling in Industry in the U.S.A.," by Mr. E. G. Taylor, M.I.E.E. The day's proceedings will begin at 9.15 a.m. and conclude at 3.45 p.m.

INTERNATIONAL TRADE CLUB.—The International Trade Club, established in connection with the South Bank Exhibition of the Festival of Britain, has arranged that a room in the Club can now be booked for periods of one day or more to enable organisations and firms to offer hospitality to business associates visiting the Exhibition. The Club is built on an island site at the junction of Westminster Bridge Road and Lambeth Palace Road, and is within 200 yards of the Exhibition. Among the facilities it provides for the business visitor are travel, accommodation and entertainment booking facilities and the services of interpreters and stenographers. It carries all trade information supplied by the Festival authorities and other bodies, together with full details of all other Festival activities throughout Britain.

SAFETY IN MINES.—A private members' Bill in the names of Colonel Crosthwaite-Eyre, Mr. Brendan Bracken, Mr. Geoffrey Lloyd, Mr. Victor Raikes, Mr. Lancaster and Colonel Clarke was tabled in Parliament on June 18th. The Bill would make it obligatory on the Minister of Fuel and Power to introduce new and comprehensive regulations covering every aspect of safety in mines within twelve months of its becoming law. Members of the Conservative Party have been pressing the Minister to introduce such regulations for some time. At the moment, apart from a few additional subjects about which the Minister can make regulations, all the industry's safety regulations spring from the 1911 Act. This Bill is designed to ensure that regulations relating to the safety and health of persons employed in mines and to mine management in all its aspects shall be brought up to date.

Personal and Business

MR. A. NEVILLE SPRIGGS has been appointed general manager of Hawker Aircraft, Ltd.

MR. ARTHUR MAKIN has been elected a director of Marshall Sons and Co., Ltd., Gainsborough.

MR. A. J. LEWIS has been appointed works officer in the chief secretary's department of the British Transport Commission.

MR. I. G. BUCHAN has been appointed chief accountant and local director of Samuel Osborn and Co., Ltd., Clyde Steel Works, Sheffield.

LONDON TRANSPORT states that Mr. E. C. Ottaway, M.I.Mech.E., at present works manager (buses and coaches), has been appointed chief supplies officer.

THE RAILWAY EXECUTIVE announces the following appointments: Mr. J. A. Broughall, executive officer (electrical engineering new works and development) at Headquarters; Mr. A. Forbes Smith, stores superintendent, Eastern and North Eastern Regions, King's Cross.

MR. T. WARD WHITFIELD, F.R.I.C.S., M.I.Struct.E., informs us that he has accepted an appointment with the Avon and Dorset River Board, in which he will act in an advisory capacity. He will continue his consulting engineering practice at Trowbridge, Wilts., and 28, Victoria Street, Westminster, S.W.1.

WOODALL-DUCKHAM, Ltd., 63–77, Brompton Road, London, S.W.3, announces the retirement of Mr. F. B. Richards from the chairmanship of the company. At the request of the directors, he will continue to serve on the board. Mr. T. Campbell Finlayson has been appointed to succeed Mr. Richards as chairman.

MR. D. G. DENOON, joint publicity manager, British Insulated Callender's Cables, Ltd., and Mr. C. H. Chaplain, manager, publicity department, the British Thomson-Houston Company, Ltd., have been elected chairman and vice-chairman respectively, of the BEAMA publicity committee for the session 1951–52.

DAVEY, PAXMAN AND CO., Ltd., Colchester, announces the following appointments: Mr. W. A. Sycamore, M.I.N.A., M.I.Mar.E., defence programme manager; Mr. H. V. Stead, M.Sc., commercial manager (engines); Mr. H. P. Brown, assistant commercial manager (engines), and Mr. J. A. Bennett-Powell, A.M.I.Mech.E., traction sales manager.

THE BRITISH TRANSPORT COMMISSION states that, following the resignation of Mr. Miles Beevor, Mr. S. B. Taylor has been appointed chief secretary to the Commission. He is deputy secretary at present. The duties performed by Mr. Beevor as legal adviser will be assumed by Mr. M. H. B. Gilmour, whose title will now be chief solicitor and legal adviser.

Contracts

THE BURNTISLAND SHIPBUILDING COMPANY, Ltd., has contracted to build a 6400 tons deadweight cargo liner for A/S Rederiet Odfjell, Bergen. The vessel will be built at the yard of Hall Russell and Co., Ltd., and has a length b.p. of 368 ft by 53ft 3in, beam by 34ft 9in depth moulded. A Wilton-Fijenoord-Doxford oil engine of 4400 b.h.p. will be fitted.

British Patent Specifications

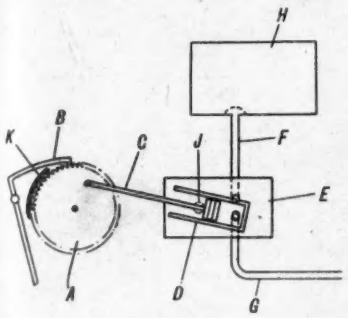
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

PUMPS

653,922. June 15, 1949.—Feed Pump, Walter Stephen John Woodward, of 22, Brockenhurst Road, Addiscombe, Croydon, Surrey; and Imperial Chemical Industries, Ltd., of Imperial Chemical House, Millbank, London, S.W.1.

This invention relates to a proportioning pump for supplying water treatment chemicals to the water in the boiler of a steam engine. The drawing shows the form of pump suitable for a locomotive engine. It is driven by a ratchet wheel *A*, 3in in diameter, having fifty teeth, rotated by a ratchet arm *B* operated by the reciprocating action of the engine. The wheel is directly connected to a ¼in crank *C*, operating the pump piston, which is ⅛in diameter with a stroke of 1¼in. The cylinder *D*



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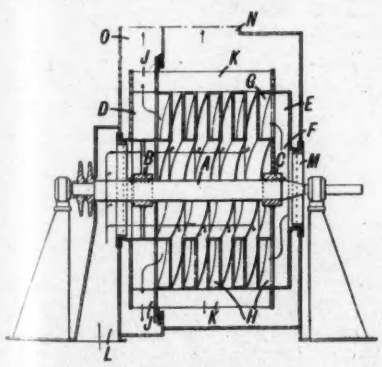
has a port near its closed end and is pivoted approximately at its centre *J* and spring-loaded on to a base plate *E*. The base plate has two pots which carry the inlet pipe *F* and the outlet pipe *G*. The cylinder oscillates with the movement of the pump crank and thereby opens and closes the inlet and outlet ports in turn by bringing the port in the cylinder opposite to them. The inlet pipe is connected through a fine sieve with a 10-gallon feed tank *H*, and the outlet pipe is fitted with a safety valve and connected through a non-return valve to the boiler. The effective turning of the ratchet wheel by each stroke can be reduced by moving the adjustable guard *K* so that it covers some of the teeth which would otherwise be operated by the arm. The arm is spring loaded. All bearings used are oil-impregnated bushes, so as to dispense with grease gun lubrication.—*May* 30, 1951.

HEAT EXCHANGERS

653,935. July 6, 1948.—Recuperative Heat Exchangers, Aktiebolaget Motala Verkstad, of Motala Verkstad, Sweden.

Referring to the drawing, a driving shaft *A* carrying rotor hubs *B* and *C* consists of two parts *D* and *E* arranged side by side. The part *E* has an axial inlet opening *F* for one of the gaseous media,



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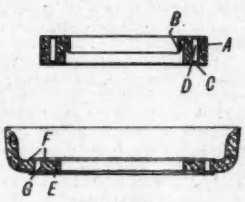
for instance, air. This inlet is in communication, through openings with two conduits *G* and *H* attached to the lateral walls of the rotor, each of these conduits having the shape of a cylindrical spiral with spaced loops. Thus, the rotor resembles a double-threaded screw with spaced threads. The conduits are provided with outlet openings, which in turn communicate with the rotor part *D*. Each rotor part is provided with a set of blades *J* and *K* respectively acting as suction fans. The rotor is mounted in a housing provided with a partition wall, which is sealed against the lateral wall of the rotor by means of a labyrinth packing. By the rotation of the rotor gas and air are simultaneously drawn through the delivery tube *L* and the axial inlet *M* respectively. The flue gases flow through the inlets into the rotor part *E*, whence they are passed radially outwards between the loops of the spiral conduits to the discharge opening *N*, while the air is drawn in an axial direction through the air inlet *M*, the inlets, the conduits and the outlets to the discharge opening *O*. Instead of two spiral conduits forming a double-threaded screw, a single conduit or more than two conduits can be used, while the two media can, if desired, be delivered by tubes arranged at the same end of the housing. The desired fan action may also be obtained by suitable adapted blowers.—*May* 30, 1951.

SHAFT GLANDS AND SEALS

653,932. June 30, 1948.—Packing Members for Stuffing-boxes and Pistons, Ronald Trist and Co., Ltd., of Bath Road, Slough; and Leonard Bomyer, of the company's address.

According to the invention, one or more rigid spacing members are provided in or on the annular body of a packing member. The packing shown in the upper view is suitable for use in a stuffing-box and has a thick annular body *A* with a flexible lip *B* attached to an inner corner. A series of holes *C* pass axially through the body and in each of these is a metal spacing rod *D* having a length slightly less than the unstressed axial length of the body.



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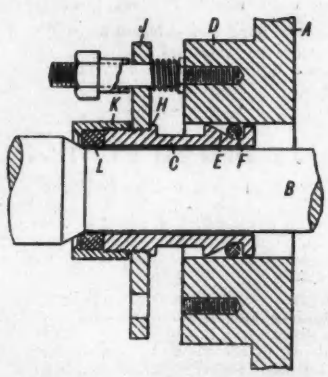
When the member is inserted in a stuffing-box the body is compressed until the load is transferred to the rods. In the course of manufacture the rods are pressed into holes previously moulded in the rubber body. The member shown in the lower view is of the cup leather type used on pistons. Its body *E* has annular ribs *F* and spacing rods *G*. A modified packing suitable for forming a complete seal between two concentric surfaces is also described in the specification.—*May* 30, 1951.

653,957. June 8, 1949.—Shaft Glands, Tate and Lyle, Ltd., and Joseph Frederick Yetman, both of Thames Refinery, Silvertown, London, E.16.

Referring to the drawing, the gland is intended to prevent the escape of fluid from one side to the other of a member *A* along the surface of a rotating



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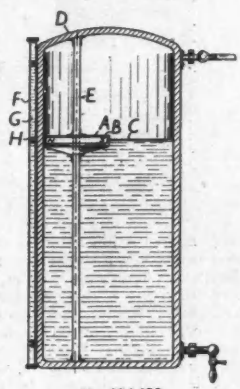
shaft *B*. It is assumed that a high-pressure fluid is in contact with the shaft to the right of the member. A sleeve *C* slidably mounted on the shaft projects at one end into a stuffing-box *D* secured to, or formed integral with, the member. The sleeve is provided with a conical seating *E*. A rubber joint ring *F* on it makes light contact with the inner wall of the stuffing-box. At its end remote from the stuffing-box the sleeve has a threaded plate *J* screwed up against a collar *H*. Studs threaded into holes in the stuffing-box pass through clearance holes in the plate *J*. Spiral springs are mounted on the studs between the plate and the stuffing-box, the extent of movement of plate being limited by collars on the studs. An internally threaded cap *K* on the threaded end of the sleeve locates a joint ring *L* on the end of the sleeve. For ease of assembly and dismantling the ring *L* is preferably made in two semicircular halves. The gland operates in the following manner:—Fluid pressure acting on the right-hand end of the sleeve and the springs urge the sleeve to the left, causing the joint ring to bear against a conical seating formed on the shaft. In this way an effective sealing is produced between the shaft and sleeve. The pressure of the fluid bearing on the joint ring *F* forces it on to the tapered seating *E*, so causing the ring to expand and form a leak-proof joint against the inner wall of the stuffing-box. Slight end play of shaft or wear of the packing ring is automatically compensated by corresponding movement of the sleeve under the influence of the fluid pressure and springs. In a similar manner the fluid pressure holds the ring in constant sealing engagement with the seating and wall as the sleeve moves to the left due to wear of the ring. A modified form of gland designed for cases where the pressure to the left of member is higher than the pressure to the right or when atmospheric pressure exists to the left of the member and a vacuum to the right is also shown in the specification.—*May* 30, 1951.

INSTRUMENTS

654,129. September 17, 1948.—Liquid Level Indicating Means, Bror Wilhelm Stromberg, of Vartagasverket, Stockholm, 5, Sweden.

As shown in the drawing, a float *A* supports a magnet *B* resting upon the surface of the liquid *C* in a sealed container *D* made of sheet aluminium. The vertical movement of the float is guided by a rail *E*, so arranged that one end of the magnet is close to the container wall. The magnet can be of the permanent bar type, horseshoe shaped, or an electromagnet. Outside the container wall and close to the magnet, is mounted a liquid-filled tube *F*, which is without any hydraulic connection with



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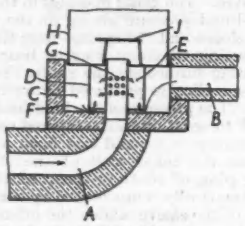
the container. In the liquid *G* a follower *H* is drawn toward the magnet. The follower is without any bond to the magnet and consists of a hollow sheet iron sphere. The density of the liquid is so adjusted that the volume of liquid displaced has the same weight as the sphere. By this means the follower is freed from gravitational restraint and follows the magnet by reason of its attractive forces, rolling in a vertical path against the wall of the tube. The tube *F* is made of glass through which the position of the follower and thus of the float, can be observed directly.—*June* 6, 1951.

BURNERS AND SPRAYERS

654,058. January 30, 1947.—Burner for Burning Vaporised Hydrocarbons, N.V. Philips' Gloeilampenfabrieken, of Emmasingel, Eindhoven, The Netherlands.

This invention relates to a burner for burning vaporised hydrocarbons with a non-luminous flame. As shown in the drawing, vaporised hydrocarbons are supplied to the burner through a tube *A*. The compressed combustion air, which has a temperature of at least 300 deg. Cent., is led to the burner through a tube *B*. This air is preheated by exhaust flue gases. In a space *C* is a cylindrical partition *D*, by which a chamber *E* is formed around the upper open-ended portion of tube *A*, which communicates with the space *C* by means of a slit *F* between the bottom of the partition *D* and the base. The upper portion of the tube, which has a diameter of, say, 10mm, has provided in its wall a number of apertures *G* offering narrow passages of not greater than 1·5mm in diameter, into the tube *A*. During the operation of the burner the compressed combustion air flows through the apertures *G* into the tube, where the combustion zone of the vaporous hydrocarbons is formed. The combustion air in this zone,

as a result of its great velocity, is in a state of turbulence, so that in this zone a mixture of the vaporous hydrocarbons and the combustion air is obtained in a very short time, the vaporised hydrocarbons thus being burnt with a non-luminous



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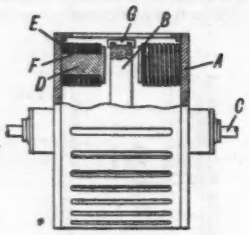
flame. The burner has on it a cylindrical shell *H* for shielding the flame, the shell having an annular bottom which fits around the upper portion of the tube and supports a tripod on which is arranged a piece of gauze *J* which serves as a flame spreader.—*June* 6, 1951.

ELECTRICAL ENGINEERING

653,758. April 14, 1948.—Electric Brakes, Societe Electro Mecanique de L'Aveyron, of Route de Severac, Rodez (Aveyron), France.

In the drawing is illustrated the general arrangement of the brake, with the exception of the electromagnet windings and the rotor cooling or ventilating fins *G*, which are shown diagrammatically. It consists of a body *A* fixed to the frame of the vehicle, inside of which is housed a magnetic metal rotor *B* rigid with a shaft *C*, which is intended to be subjected to the braking action. Inside the body, on either side of the rotor, are fixed electromagnets, each of which is constituted by a pole piece *D* and a



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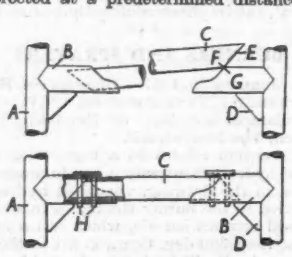
winding or coil *E*, insulation between the coil and the pole piece being, for instance, ensured by an insulating layer *F*. This coil can be connected, through a switch, with a source of current. When electric current flows through the coils of the pole pieces, the rotor, which revolves together with shaft, intersects the lines of force of the magnetic field produced by the energising of the electromagnets, and is thus subjected to a powerful braking effect corresponding to the creation of eddy currents inside the rotor. The energy of the eddy currents is transformed into heat which is to be dissipated. Methods of constructing the windings and the cooling fins are given in the specification.—*May* 23, 1951.

STRUCTURAL ENGINEERING

653,861. May 24, 1948.—Tubular Scaffolding, Ernest Goodall Malthouse, of Cliffe Field Works, Derbyshire Lane, Sheffield, 8.

Referring to the drawings, standards *A* intended to be erected at a predetermined distance apart,



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carry welded sockets *B* of, say, $2^9/_{64}$in internal diameter to receive a length of tube *C* of 2in outside diameter. The sockets are stiffened by gussets *D*. The open end of each socket is longer on the lower side than on the upper side. Each end *E* of the tube *C* is cut at 45 deg. and the length of the tube is such that the distance between the points *F* equals the distance between the points *G* of a pair of sockets. With the tube in the position shown, one end of the tube is inserted into one of the sockets, the slight tilting of the tube permitting the point *E* at the other end to pass the point *F* of the socket at that end, after which the angular end *E* combined with the slight diametral clearance between the other end of the tube and the socket, permits the tube to reach the position shown in the lower view, the one end of the tube substantially reaching the standard inside the socket and the other end of the tube resting on the lower side of the other socket. The tube is then retracted slightly in one socket and rotated through 180 deg. to bring the ends to the position shown. A pair of locking pins *H* carried by a curved plate inserted through holes prevents displacement of the tube. Various modifications and applications are also shown in the specification.—*May* 30, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Incorporated Plant Engineers

Tues., July 3rd.—Birmingham Branch: All-day visit to Manchester Oil Refineries and Petrochemicals, Ltd.

Wed., July 4th.—E. Midlands Branch: Evening Visit to British Plaster Board, Ltd., East Lake.

Wed., July 11th.—E. Lancs. Branch: Visit to Small and Parkes, Herdham Vale, Manchester, 12.45 p.m., for lunch, afternoon visit and tea.

Thurs., July 12th.—Newcastle upon Tyne Branch: Roadway House, 8, Oxford Street, Newcastle upon Tyne, "Oil in Industry," I. A. Howden, 7.30 p.m.

Wed., July 18th.—E. Midlands Branch: Evening Visit to General Refractories, Ltd., Worksop.

Sat., July 21st.—Birmingham Branch: Morning Visit to B.E.A., Hams Hall "B" Station.

Institution of Mining Engineers

Wed. to Fri., July 4th to 6th.—Summer Meeting, Nottingham.

Institution of Sanitary Engineers

Fri., July 6th.—Caxton Hall, Westminster, S.W.1, Annual General Meeting, 5.15 p.m., "From Thames to Tap," Gordon Carter, 6 p.m.

Sat., July 7th.—Visit to Metropolitan Water Board Laboratories, New River Head, Rosebery Avenue, E.C.1, 9.45 a.m.

International Conference of Naval Architects and Marine Engineers, 1951

Thurs., July 5th.—Newcastle upon Tyne: Literary and Philosophical Society, Westgate Road, "U.S. Fleet Maintenance and Battle Damage Repairs in the Pacific during World War II," Ralph K. James; "Stresses in Propellers and Propeller Shafting under Service Conditions," S. F. Dorey, 10 a.m.

Royal Meteorological Society

Wed., July 18th.—Summer Meeting at East Malling Research Station, East Malling, Maidstone.

Launches and Trial Trips

Cornwall, motor cargo liner; built by Alexander Stephen and Sons, Ltd., for the Federal Steam Navigation Company, Ltd.; length 460ft, breadth 62ft 6in, depth 40ft 3in, load draught 26ft 6in, deadweight 9800 tons; sea speed 16 knots. Launch, June 21st.

Western Coast, cargo vessel; built by the Goole Shipbuilding and Repairing Company, Ltd., for Coast Lines, Ltd.; length b.p. 220ft, breadth 35ft, depth to shelter deck 21ft, deadweight 1250 tons; British Polar diesel engine, 1140 b.h.p. at 250 r.p.m., speed 12 knots. Launch, June 19th.

Cape St. Mary, diesel research trawler; built by Hall, Russell and Co., Ltd., for the Crown Agents for the Colonies; length overall 117ft, breadth moulded 25ft, depth moulded 12ft 6in; diesel engine supplied by National Gas and Oil Engine Company, Ltd., 350 b.h.p. at 550 r.p.m.; S.L.M. reverse reduction gearing. Trial June 13th.

Port Nelson, refrigerated cargo vessel; built by Harland and Wolff, Ltd., for the Port Line; length between perpendiculars 460ft, breadth moulded 64ft 6in, depth moulded to upper deck 41ft 6in, gross tonnage 8150; Harland-Burmeister and Wain, single acting, two-cycle opposed piston oil engine, seven cylinders 750mm diameter by 2000mm combined stroke, 112 r.p.m.; two vertical multitubular boilers, three W. H. Allen 295kW diesel generators. Launch June 19th.

Stanburn, cargo ship; built by the Burntisland Shipbuilding Company, Ltd., for the Stanhope Steamship Company, Ltd.; length between perpendiculars 435ft, breadth moulded 59ft 6in, depth to shelter deck 38ft 11in, deadweight 10,300 tons, draught 25ft 10in; Hawthorn-Doxford oil engine, four cylinders 600mm diameter by 2320mm combined stroke, arranged to burn heavy fuel, 3300 b.h.p., one multitubular boiler and one vertical composite boiler. Launch, June 20th.

British Viscount, motor tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for the British Tanker Company, Ltd.; length b.p. 463ft 5½in, breadth moulded 61ft 9in, depth moulded 34ft 1in, deadweight 12,167 tons on summer draught 27ft 7½in; twenty-seven cargo oil tanks, four 270 tons per hour oil cargo pumps, steam deck machinery; Swan Hunter Doxford oil engine, four cylinders, 3100 b.h.p. at 105 r.p.m., two Scotch multitubular boilers. Service speed 11½ knots. Trial, June 20th.

Port Townsville, refrigerated cargo vessel; built by Swan, Hunter and Wigham Richardson, Ltd., for the Port Line; length between perpendiculars 460ft, breadth moulded 64ft 6in, depth moulded to upper deck 41ft 6½in, deadweight 10,700 tons, load draught 28ft 8½in; Wallsend-Doxford oil engine, six cylinders 725mm diameter by 2250mm combined stroke, 7500 b.h.p. at 114 r.p.m.; two vertical Cochran boilers, three W. H. Allen 295kW diesel generators, service speed 15½ knots. Launch, June 21st.

Stavik, motor tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for Aktieselskapet Har and Aktieselskapet Hartank, Oslo; length between perpendiculars 465ft, breadth moulded 63ft 6in, depth moulded 36ft 3in, load draught 28ft 1½in, deadweight 13,575 tons; twenty-seven cargo oil tanks, two pump rooms, four steam horizontal Duplex pumps; steam deck machinery; Wallsend-Doxford oil engine, four cylinders 670mm diameter by 2320mm combined stroke, 3750 b.h.p. at 100 r.p.m., two multitubular boilers, service speed 12½ knots. Trial, June 20th.

Catalogues

G. and J. Weir, Ltd., Cathcart, Glasgow, S.4.—Publication describing economiser condensers.

Grantham Boiler and Crane Co., Ltd., Grantham, Lincs.—Leaflet describing range of standard boilers.

David Brown Machine Tools, Ltd., Manchester.—Leaflet describing the MT-V spline hobbing machine.

Hopkinsons, Ltd., Huddersfield.—Booklet 5100, giving a brief history and an outline of present activities.

Aldridge Tool and Engineering Co., Ltd., Aldridge, Near Walsall, Staffs.—Standard and special tool catalogue.

Holman Bros., Camborne, Cornwall.—Leaflet No. D.1096/51, illustrating and describing SL.280 Sinker-Airleg combination.

C. C. Wakefield and Co., Ltd., 46, Grosvenor Street, London, W.1.—Publication entitled "Steel Works Lubrication."

Hills (West Bromwich), Ltd., Albion Road, West Bromwich.—Brochure giving details of "Hills Presweld School Construction."

British Tyre and Rubber Co., Ltd., Herga House, Vincent Square, London, S.W.1.—Booklet dealing with conveyor belt maintenance.

Electromagnets, Ltd., Boxmag Works, Bond Street, Birmingham, 19.—Leaflet No. 50, giving details of electromagnetic clutches.

Sharples Centrifuges, Ltd., Woodchester, Stroud, Glos.—Bulletin No. 351, dealing with purification of heavy boiler oil for diesel engines.

British Jeffrey-Diamond, Ltd., Sternard Works, Wakefield, Yorks.—Catalogue No. 1462, illustrating and describing "Spiro" compressed air turbines.

Burton, Griffiths and Co., Ltd., Small Tools Division, Montgomery Street, Birmingham, 11.—Schedule of small tools, British, American and European.

David Brown Foundries Co., Penistone, Near Sheffield.—Publication illustrating the composition, manufacture and application of Taurus bronze castings.

END OF VOL. CXCI

The Engineer

JUNE 29, 1951 28, ESSEX ST., STRAND, LONDON, W.C.2 TWO SHILLINGS

UNIVERSITY OF MICHIGAN
JUL 18 1951
ENGINEERING LIBRARY

Slough to Sydney, Rotherham to Rio

A shareholder writes: "The maps accompanying the annual report of Bell's fascinate me. The Trade Symbol must be familiar from China to Peru. Surely the salamander travels to the farthest edges of the earth. Slough is known in Sydney, Rotherham in Rio." By alliteration's aid Antwerp to Ahmedabad, Reykjavik to Rangoon, might be added from the comprehensive list of places. Where engineering begins and industry expands, Asbestos in different forms and usages, each of special character and purpose, is the proved, trusted, obedient servant. Packings, jointings, insulations are among the essentials; no longer is the salamander a remote legend, but an industrial fact the wide world over, Asbestos being on the far-flung air-routes and in the structure and service of the planes themselves, in jet aircraft no less. Our annual report was enfolded in "an illustration of one of the most spectacular achievements in insulation ever attempted anywhere in the world." That was on Horten Spheres at the Government of India Fertilizer Factory at Sindri, Bihar. Rotherham, in our Shareholder's letter refers to W. N. Baines & Co., Ltd., one of our Group of Companies. Valves and steam fittings made by Baines excel in design, quality and craftsmanship and carry their own fame. At Slough and at Rotherham the maps exhilarate us in speeding to the summons of engineering at home and abroad, from Glasgow to Gwelo, from Cardiff to Ceylon.

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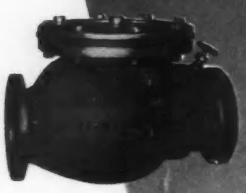
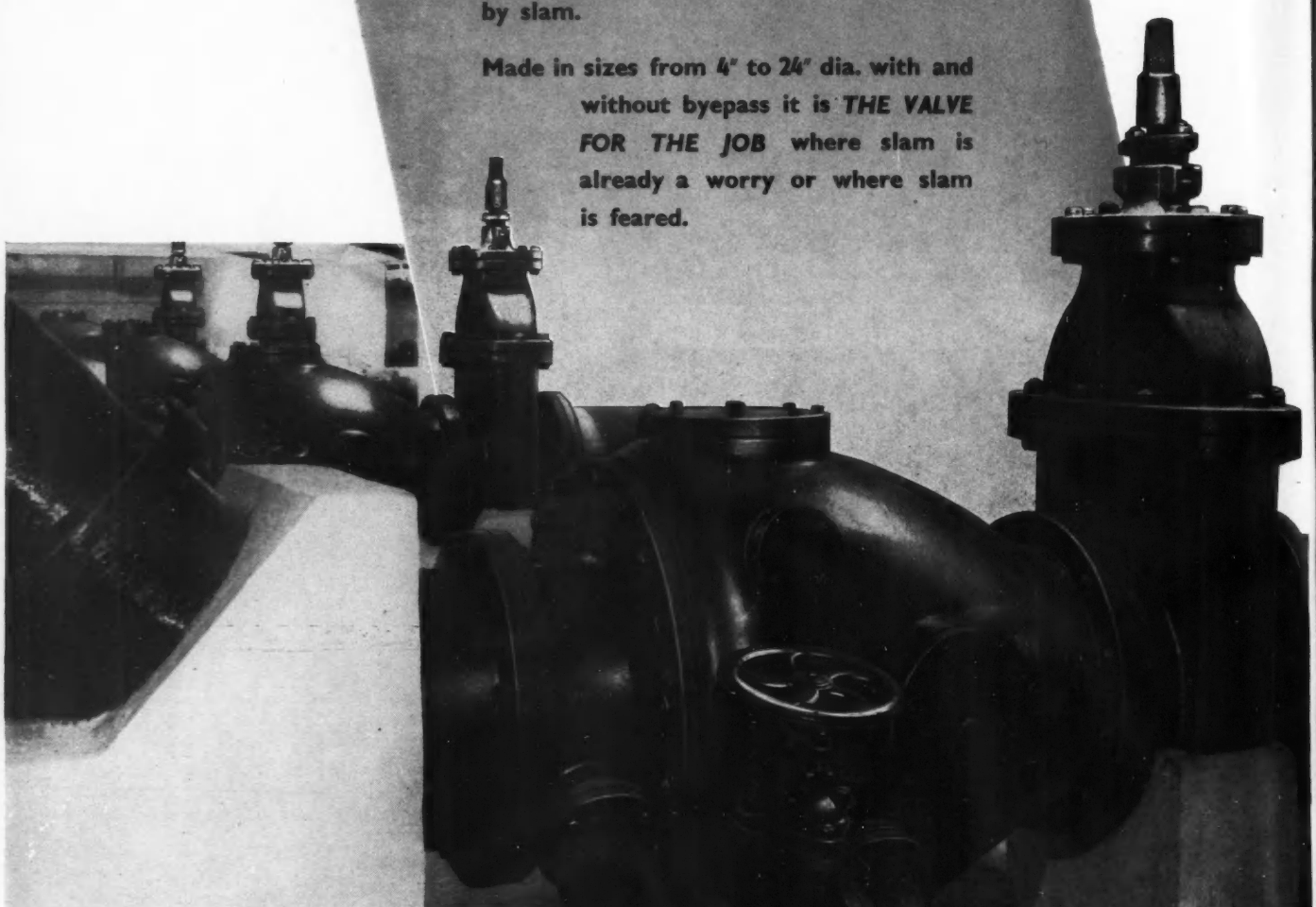


and thus safeguards the Pumping Plant against damage by slam,

as it also safeguards the main against damage by water hammer which develops by slam.

Made in sizes from 4" to 24" dia. with and without byepass it is *THE VALVE FOR THE JOB* where slam is already a worry or where slam is feared.



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Glenfield

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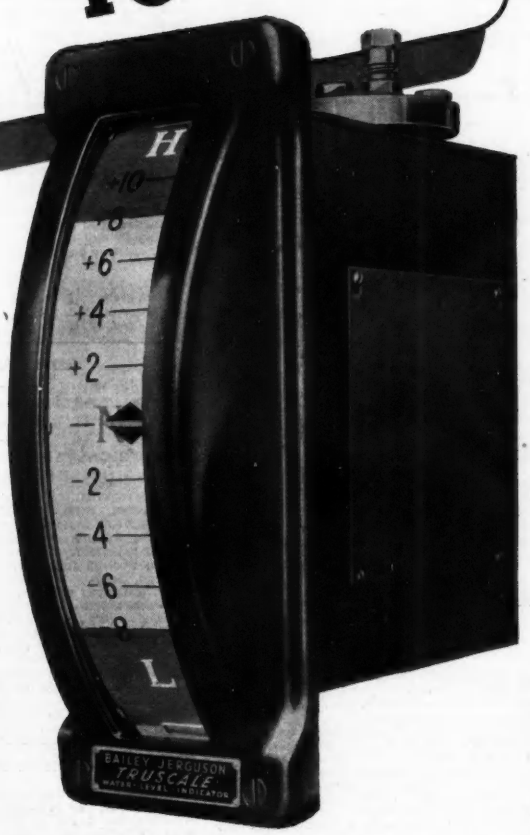

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Accuracy has not been sacrificed to rugged construction and dependability in this new instrument suitable for land or marine service.

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BRITISH INSTRUMENT EXHIBITION—JULY 4th-14th ROW D, STAND 5, NATIONAL HALL, OLYMPIA

The Engineer

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NOTICE TO READERS

All letters intended for insertion in 'The Engineer' or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

SUBSCRIPTIONS

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WORDING OF ADVERTISEMENTS: Approximately the first 25 letters of each advertisement are set in heavy type. Advertisers are therefore advised to begin their advertisements with the words they want emphasized.

Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC NOTICES

UNIVERSITY OF ABERDEEN

NATURAL PHILOSOPHY DEPARTMENT

LECTURER IN ENGINEERING MATHEMATICS

Applications are invited for the post of LECTURER IN ENGINEERING MATHEMATICS (including Pure and Applied Mathematics and Mathematical Physics). The Lecturer's main duties will be to teach Honours students in engineering science, and to advise on mathematical aspects of the research of the Engineering Department. Salary in the range of £1100 by £50 to £1300 with F.S.S.U. and children's allowances. Initial placing according to qualifications and experience. The University pays a proportion of furniture removal expenses.

Applications should reach the Secretary to the University (from whom forms of application and conditions of appointment may be obtained) not later than 1st August, 1951.

H. J. BUTCHART,
Secretary.
The University, Aberdeen. E9040

UNIVERSITY OF ABERDEEN

LECTURESHIP IN ENGINEERING

Applications are invited for a LECTURESHIP IN ENGINEERING. Salary £550 by £50 to £800, with F.S.S.U. and family allowance. The University pays a part of removal expenses. Candidates should hold an Honours Degree in Mechanical Engineering and have had industrial and/or research experience.

Applications should reach the Secretary to the University (from whom forms of application and conditions of appointment may be obtained) not later than 27th July, 1951.

H. J. BUTCHART,
Secretary.
The University, Aberdeen. E9041

UNIVERSITY OF EDINBURGH

DEPARTMENT OF ENGINEERING

ASSISTANT

Applications are invited for the post of ASSISTANT in the Department of Engineering. Salary £450 to £550 per annum, depending on qualifications. Candidates should possess an Honours Degree in Engineering and be particularly interested in applied mechanics.

Applications, containing the names of two referees, should reach the Secretary to the University by 21st July, 1951, from whom further details may be obtained.

June, 1951. E9025

THE UNIVERSITY OF MANCHESTER

LECTURERS IN ENGINEERING

Applications are invited for the following posts: ONE SENIOR LECTURER IN ENGINEERING; ONE LECTURER IN ENGINEERING.

Salary scales for Senior Lecturers, £1150 by £50 to £1500, and for Lecturers, £500 by £50 to £900 by £50 to £1100. Initial salary according to qualifications and experience. Membership of F.S.S.U. and children's allowance scheme.—Applications to be submitted not later than July 15th, 1951, to the Registrars, The University, Manchester, 13, from whom further particulars and application forms may be obtained. E9075

UNIVERSITY COLLEGE OF SWANSEA

SENIOR RESEARCH STUDENTSHIP

Applications are invited for a SENIOR RESEARCH STUDENTSHIP in ENGINEERING tenable for one year from October 1st, 1951, with the possibility of renewal for a second year. Applicants should have qualifications in Mathematics, Physics, Chemistry, Engineering or Metallurgy. The value of the Studentship will be within the range £400 to £500 per annum.—Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received without delay. E9072

EGYPTIAN GOVERNMENT

FAROUK I UNIVERSITY, ALEXANDRIA

Applications are invited for the following PROFESSORSHIPS at the Faculty of Engineering:—Naval Architecture and Marine Engineering; Power Stations (Mechanical); Strength of Materials and Sanitary Engineering.

Candidates must possess *Ph.D.* or higher qualification, University teaching, practical experience, original researches and publications. The appointments will be on contract for two years, renewable, at a salary to be fixed according to qualifications and experience, and become effective from date of taking up duties. Travelling expenses to Egypt and return on completion of a specified contract period will be paid.

Applications, giving full details, should be submitted to the Director-General, Egyptian Education Bureau, 4, Chesterfield Gardens, Curzon Street, London, W.1, so as to be received not later than 25th July, 1951. E9039

UNIVERSITY COLLEGE OF SWANSEA

LECTURER IN METALLURGY

Applications are invited for the post of LECTURER IN METALLURGY. Salary on the scale £550, rising annually by £50 to £1100 per annum, with an efficiency bar at £850. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received without delay. E8971

OLDHAM EDUCATION COMMITTEE

MUNICIPAL TECHNICAL COLLEGE

Principal: E. M. STODDART, B.Sc., Ph.D. (London, Ph.D. (Dunelm), F.R.I.C.

DEPARTMENT OF MECHANICAL ENGINEERING

GRADE "A" ASSISTANT

Applications are invited for the appointment of a GRADE "A" ASSISTANT in the Department of Mechanical Engineering. Candidates should be qualified to teach Workshop Theory and Practice up to the final year of the City and Guilds Course and National Certificate subjects up to at least the second year of the course. The minimum qualifications required are either a Higher National Certificate in Production Engineering or the City and Guilds Final in Machine Shop Engineering, together with the Ordinary or Higher National Certificate in Mechanical Engineering. Toolroom experience in industry will be an advantage.

Salary will be in accordance with the Burnham Technical Report, 1951, for Grade "A" Assistants, namely, £375, rising to £630 per annum, together with approved additions for degree and training: allowance is made for previous teaching and industrial service. Forms of application and further particulars may be obtained from the undersigned, to whom they should be returned within fourteen days of the appearance of this advertisement.

MAURICE HARRISON,
Director of Education.
Education Offices,
Union Street West,
Oldham,
9th June, 1951. E8962

GATESHEAD EDUCATION COMMITTEE

THE TECHNICAL COLLEGE, DURHAM ROAD, GATESHEAD

Principal: J. S. ELLIOTT, B.Sc. (Hons.) Eng., A.M.I.Mech.E., M.I.Prod.E.

Applications are invited for the post of ASSISTANT Grade B in the Department of Engineering, to take work up to National Certificate Standard.

Candidates should be graduates of a British University, or possess equivalent qualifications, and have had suitable industrial and some teaching experience. They will be expected to teach Heat Engines and Applied Mechanics, together with Engineering Science and Engineering Drawing. Duties to commence on 1st September, 1951, or as soon thereafter as possible.

Salary scale: Grade B: £450 by £25 to £725, together with appropriate allowances for degree and training. Approved industrial experience after the age of 21 years will rank for incremental purposes up to a maximum of 12 increments.

An application form may be obtained on receipt of a stamped, addressed, foolscap envelope and should be returned to the undersigned within a fortnight of the appearance of this advertisement.

W. N. HOWARD,
Director of Education.
Education Office,
Prince Consort Road, S.,
Gateshead, 8,
18th June, 1951. E8966

OLDHAM EDUCATION COMMITTEE

MUNICIPAL TECHNICAL COLLEGE

Principal: E. M. STODDART, B.Sc., Ph.D. (London), Ph.D. (Dunelm), F.R.I.C.

DEPARTMENT OF ELECTRICAL ENGINEERING

ASSISTANT GRADE "B"

Applications are invited for the appointment of a Full-time ASSISTANT, GRADE "B" in the Department of Electrical Engineering. Candidates should possess Graduate qualifications and should have had experience both in industry and in the teaching of Electrical Engineering subjects. The ability to teach mathematics to electrical engineering students would also be expected.

The salary will be in accordance with the Burnham (Further Education) Report, 1951, for Grade "B" Assistants, namely, £450 by £25 to a maximum of £725 per annum, with approved additions for degree and training.

Forms of application and further particulars may be obtained from the undersigned, to whom they should be returned not later than 14 days after the date of appearance of this advertisement.

MAURICE HARRISON,
Director of Education.
Education Offices,
Union Street West,
Oldham. E8961

OLDHAM EDUCATION COMMITTEE

MUNICIPAL TECHNICAL COLLEGE

Principal: E. M. STODDART, B.Sc., Ph.D. (London), Ph.D. (Dunelm), F.R.I.C.

DEPARTMENT OF ELECTRICAL ENGINEERING

LECTURER

Applications are invited for the appointment of a full-time LECTURER in the Department of Electrical Engineering. Candidates should possess Graduate qualifications and should have had experience both in industry and in the teaching of Electrical Engineering subjects, including Electronics and Advanced Mathematics.

The salary will be in accordance with the Burnham (Further Education) Report, 1951, for Lecturers, namely, £900 by £25 for a maximum of £1000 per annum.

Forms of application and further particulars may be obtained from the undersigned, to whom they should be returned not later than 14 days after the appearance of this advertisement.

MAURICE HARRISON,
Director of Education.
Education Offices,
Union Street West,
Oldham. E8963

SOUTHEND WATERWORKS COMPANY

APPOINTMENT OF DEPUTY CHIEF ENGINEER

Applications are invited from qualified persons for the above appointment at a commencing salary between £1500 and £1700 per annum, according to the age, experience, &c., of the successful candidate.

A house of reasonable size will be available.

Applicants should possess wide knowledge of the design, construction and operation of waterworks of some magnitude. Experience of abstraction and treatment of river waters would be of value.

Candidates should not be more than 45 years of age.

The appointment (which will be terminable by three months' notice on either side) will be subject to admission to the Company's contributary superannuation scheme (details of which are available), and a satisfactory medical report.

Applications, endorsed "Deputy Chief Engineer," stating age, qualifications and experience, accompanied by copies of three recent testimonials, and the names and addresses of three persons to whom reference may be made, should be sent to the undersigned not later than July 16th, 1951.

WALTER FIDKIN, M.I.C.E.,
Chief Engineer.
13, Cambridge Road,
Southend-on-Sea,
June 21st, 1951. E9033

SUDAN GOVERNMENT

THE PUBLIC WORKS DEPARTMENT

ROAD ENGINEER

The Public Works Department requires a ROAD ENGINEER, aged 32–40 years, for service in the Sudan. The duties consist of the location and construction of new roads.

Candidates should be A.M.I.C.E. (or equivalent qualifications) and have a sound knowledge of road location and soil stabilisation. They should have had extensive experience of all kinds of road construction, particularly construction of low-cost roads with modern mechanical equipment.

Appointment will be on short term contract for a period of two years, with or without eligibility for bonus, as may be agreed. Salary ranges from £E.771 to £E.1512 if contract provides for a bonus and from £E.822 to £E.1933 if it does not.

A cost-of-living allowance is at present payable from £E.142 to £E.352 per annum, according to the number of dependants. There is at present no income tax in the Sudan. An outfit allowance of £E.60 is payable on appointment, subject to certain limitations. Free passage on appointment.

Further particulars and application form may be obtained on written application from the Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1. Please mark envelopes "Road Engineer P.W.D. 4/104/S." E8970

LONDON COUNTY COUNCIL

CHIEF ENGINEER'S DEPARTMENT

(a) CIVIL ENGINEERING ASSISTANTS, and (b) CIVIL ENGINEERING DRAUGHTSMEN required in connection with main drainage works generally and for design of large diffused air and sludge digestion plants and ancillary works in preparation for extensive development of the Council's sewage purification works. Opportunities may be available later for a limited number to take part in supervision of the construction of the works.

Candidates should be good draughtsmen, and for position (a) should have had design experience.

Rates of pay: (a) up to £580 a year; (b) up to 167s. 6d. a week.

(Rates of pay quoted are at present subject to an addition of 10 per cent.)

Application forms obtainable by sending stamped, addressed foolscap envelope to Chief Engineer, County Hall, Westminster Bridge, S.E.1 (quoting 51/30), returnable within fourteen days of appearance of this advertisement.

Canvassing disqualifies. (735.) E8793

MANCHESTER CORPORATION WATERWORKS

HAWESWATER AQUEDUCT

APPOINTMENT OF ASSISTANT ENGINEERS

Applications are invited for the undermen... Engineering appointments in connection ... the supervision, &c., of the work of constr... of the Haweswater Aqueduct, now in ... progress:—

ASSISTANT ENGINEERS (Class I): ... per annum, £780–£1100.

ASSISTANT ENGINEERS (Class II): ... per annum, £570–£760.

ASSISTANT ENGINEERS (Class III): ... per annum, £470–£575.

Commencing salaries will be fixed within ... above limits according to qualifications ... experience. Where Assistant Engineers ... I) possess appropriate specialised experience ... tunnelling, the commencing salary will be ... than £900 per annum.

Assistant Engineers (Classes I and II) ... provided with housing accommodation at a re... able rental. Accommodation may be availa... some cases for Assistant Engineers (Class III).

The appointments will be to the temporary ... of the Corporation and for the period requi... the construction of the Haweswater Aque... which will extend over a further 3 to 3½ years, ... comprises tunnels, covered channels, pipe-lines ... special works.

The successful applicants will be require... pass a medical examination, to contribute to ... Manchester Corporation superannuation fund, ... to conform to the Standing Orders of the Corp...

Applications, stating (1), age, (2) education ... training, (3) professional qualifications, (4) exp... ence in the preparation of plans and constr... of waterworks or other civil engineering w... also indicating the class of appointment ap... for, must be accompanied by copies of two re... testimonials and addressed to me, end... "Application for Engineering Appointm... Haweswater Aqueduct," so as to be received ... later than the 16th July, 1951.

Canvassing in any form is prohibited, and ... tionsanip to any member of the Council or a... officer must be disclosed in writing to me.

PHILIP B. DINGLE,
Town Clerk.
Town Hall,
Manchester, 2,
June, 1951. E90...

ADMIRALTY

ADMIRALTY RESEARCH AND DEVELOPMENT ESTABLISHMENTS

ELECTRICAL AND/OR MECHANICAL ENGINEERING DRAUGHTSMEN

Vacancies exist for ELECTRICAL and MECHANICAL ENGINEERING DRAUGHTSMEN in Admiralty Research and Development Establishments located in the vicinity of Wormouth, Portsmouth, Teddington (Middlesex) and Baldock, Herts.

Draughtsmen experienced in light current electro-mechanical, precision mechanical or electronic equipment are particularly needed.

Candidates must be British subjects of 21 years of age and upwards, who have had practical workshop experience (preferably an apprenticeship) together with drawing-office experience.

Appointments will be in an unestablished capacity, but opportunities may occur for qualified staff to compete for established posts.

The salaries offered, depending on age, experience, ability and place of duty, will be within the range £320–£560 p.a.

Hostel accommodation is available at some establishments.

Applications, stating age and details of technical qualifications, apprenticeship (or equivalent) workshop and drawing-office experience, should be sent to Admiralty (C.E.II, Room 88), Empire Hotel, Bath, quoting DM/R.D. Original testimonials should not be forwarded with applications. Candidates required for interview (at London or Bath, whichever is nearer) will be advised within two weeks of receipt of application. E902...

MINISTRY OF SUPPLY

PRINCIPAL SCIENTIFIC OFFICER

ENGINEERS are invited to apply for the following unestablished appointments in the grade of PRINCIPAL SCIENTIFIC OFFICER in the Ministry of Supply, London Headquarters:—(Ref. C355/51A): to take charge of a section responsible for initiation and co-ordination of research and development work on aircraft pressure cabins, and associated problems and equipment; the supervision of such installations in military and civil aircraft; crew safety measures associated with pressure cabin operation; up-to-date knowledge of aircraft design and installations is essential. (2) (Ref. C 356/51A): to control a section responsible for co-ordinating investigations with mechanical engineering problems in connection with aircraft development. A good knowledge of aircraft design and construction is essential and experience of Ministry of Supply procedure would be of advantage. Candidates must be of at least thirty-one years of age and possess a First or Second-Class Honours Degree in Mechanical Engineering. Experience in the duties outlined is necessary. Salary according to age, qualifications and experience within the range £1000 to £1375. Rates for women somewhat lower. Post carries benefits of F.S.S.U.—Application forms obtainable from Ministry of Labour and National Service, Technical and Scientific Register (... York House, Kingsway, W.C.2, quoting appropriate reference number. Closing date 31st July, 195... E90...

PUBLIC NOTICES

HIS MAJESTY'S COLONIAL SERVICE, MALAYA

DEPARTMENT OF DRAINAGE AND IRRIGATION

ASSISTANT CIVIL ENGINEERS

There are several vacancies in the Department of Drainage and Irrigation, Malaya, for ASSISTANT CIVIL ENGINEERS. The duties include surveys and preparation of designs for irrigation works and water control, execution of works by contract and direct labour.

Appointment will be on probation for permanent and pensionable employment in the incremental scale of 440 dollars by 30 dollars to 1000 dollars per month (£614 by £42 to £1400 per annum at present rates of exchange), initial salary depending on experience and war service. Cost-of-living allowance is payable at approved Government rates subject to the following maxima :—£707 per annum for married officers with dependent children, £602 per annum for married officers without dependent children, £336 for single officers. Expatriation pay, which is pensionable, is paid at rates varying from £126 to £231 per annum. Free passages for officers, and, if married, for their wives and children, are granted on first appointment and on leave. Generous home leave on full pay is granted after a first tour of three to four years, the length of tour decreasing with length of service. Malayan income tax is payable at low rates.

Candidates must be British subjects, aged preferably between 24 and 35. They must be exempted, or have passed, Sections " A " and " B " of the A.M.I.C.E., and have had at least two years' civil engineering experience. Preference will be given to those with experience gained in River Catchment Boards.

Engineers employed by local authorities in the United Kingdom can preserve superannuation rights.

For a form of application and further information, write, giving brief particulars of age, qualifications and experience, to the Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1. Please mention this paper and quote No. 27329/24.

E9014

YORKSHIRE OUSE RIVER BOARD

ENGINEER'S DEPARTMENT

ENGINEERING ASSISTANTS

Applications are invited for the following appointments : ENGINEERING ASSISTANT, Class IV (two posts—one at York and one at Doncaster).

Candidates should preferably have had experience in land drainage and river improvement works.

Salary scales :—

Graduates.—Within £440 to £620 per annum, according to qualifications and experience.

Non-Graduates with at least three years' appropriate training.—Within £470 to £620 per annum, according to qualifications and experience.

Note.—In both cases progression beyond £575 will be dependent on passing the final examination of an approved professional body.

ENGINEERING ASSISTANT, Class III (two posts—one at York and one at Doncaster).

Candidates must have had experience in land drainage and river improvement works and have passed the final examination of the Institution of Civil Engineers or other approved professional examination.

Salary scale : Within £570 to £660, according to experience.

Subsistence and motor-car allowances are payable.

Conditions of appointments and forms of application may be obtained from the Engineer, Yorkshire Ouse River Board, 21, Park Square South, Leeds, 1.

Applicants for further details should state clearly for which of the posts it is intended to apply.

H. J. PAUL,
Engineer to the Board.

18th June, 1951. E8984

CROWN AGENTS FOR THE COLONIES

CENTRAL ELECTRICITY BOARD

ELECTRICAL ENGINEER

ELECTRICAL ENGINEER (MECHANICAL) required by the Central Electricity Board, Federation of Malaya, for 3 years, with prospect of permanency. Salary (including Expatriation Pay) payable in local currency, equivalent at the present Government rate of exchange to £742 a year, rising to £1652 a year. Commencing salary according to age and experience. Cost of living allowance equivalent to between £336 and £707 a year, according to salary and dependants. Free passages. Liberal leave on full salary. Candidates between 24 and 35 years of age must have had a good general education and be Corporate Members or Graduates of the Institutions of Electrical or Mechanical Engineers or possess equivalent qualifications, and have had sound training in both electrical and mechanical engineering with experience in the operation and maintenance of diesel-alternator generating plant of up to 1000kW units. Experience in an electricity supply undertaking would be a distinct advantage.

Apply at once by letter, stating age, full names (in block letters) and full particulars of qualifications and experience and mentioning this paper to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M.28370.B on both letter and envelope. The Crown Agents cannot undertake to acknowledge all applications and will communicate only with applicants selected for further consideration. E8995

PUBLIC NOTICES

MID AND SOUTH-EAST CHESHIRE WATER BOARD

APPOINTMENT OF ENGINEERING ASSISTANT

Applications are invited for the appointment of ENGINEERING ASSISTANT on the permanent staff at a salary in accordance with Grade A.P.T. V of the National Scale of Salaries (£570 to £620).

Applicants should have experience in the design, construction and maintenance of waterworks buildings and structures or similar works. They should preferably be Corporate Members of the Institution of Civil Engineers or the Institution of Structural Engineers.

The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, to the passing of a medical examination and to the National Joint Council Scheme and Conditions of Service.

Forms of application can be obtained from the Engineer and Manager at the address given below and should be returned to him not later than 10 a.m. on Monday, 16th July, 1951.

Testimonials will not be required but the name of three persons to whom reference can be made will be necessary.

The Board cannot undertake to find housing accommodation for the successful applicants.

Canvassing, either directly or indirectly, will disqualify and applicants must state whether to their knowledge they are related to any Member or Senior Officer of the Board.

C. J. WALKER,
Clerk and Accountant.

Mid and South-East Cheshire Water Board,
Weaverham Grange,
Hartford,
Nr. Northwich,
Cheshire. E8986

MINISTRY OF SUPPLY

ATOMIC ENERGY DIVISION

ENGINEER I (UNESTABLISHED)

ENGINEER I (UNESTABLISHED) required by Ministry of Supply Establishment in Lancashire. Candidates, British, of British parentage, should have served a regular engineering apprenticeship and either be Corporate Members of one of the Institutions of Electrical, Mechanical or Civil Engineers, or possess exempting qualifications. Considerable experience in an executive capacity in heavy or medium electrical industry and very wide electrical background essential; knowledge of instrumentation and high vacuum testing an advantage. Duties : to be responsible for the organisation and technical administration of the inspection of electrical and allied equipment ordered by Atomic Energy Division. Salary, £997–£1192 p.a. There will be periodical competitions for establishment.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), York House, W.C.2, quoting D 288/51-A. Closing date 31st July, 1951.

E9010

GOLD COAST

VOLTA RIVER HYDRO-ELECTRIC PROJECT

Applications are invited for the following posts on the staff of the Chief Civil Engineer.

ACCOUNTANT. Salary up to £100 per month.

CLERK/STOREKEEPER. Salary up to £60 per month.

DRAUGHTSMAN/DESIGNER, preferably with experience of design of irrigation, water supply, roads and railway works. Salary up to £70 per month.

The above are maximum commencing salaries, the actual sums will be decided upon according to experience of successful candidates.

Free passages. Good leave between each tour, which will be of 18 months' duration.

Applications with particulars of qualifications and experience and references to previous employers to be sent to the Engineers, Sir William Halcrow and Partners, MM.I.C.E., Alliance House, Caxton Street, Westminster, S.W.1.

E8989

LYDNEY RURAL DISTRICT COUNCIL

WATER SUPPLY—CONTRACT NO. 2

APPOINTMENT OF RESIDENT ENGINEER

Applications are invited for the above appointment to supervise the construction of 2 miles of 9in. diameter water main. The work will be executed by Contract and will be under the direction of the Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 18, Queen Anne's Gate, Westminster, S.W.1.

The salary is £650 per annum, of which £150 per annum will be considered a lodging subsistence allowance and not subject to P.A.Y.E. deduction. The appointment is subject to satisfactory service and is expected to last approximately six months, and will be terminable by one month's notice on either side.

Applicants, who should have had experience of similar work, should apply in writing to the undersigned, not later than the 6th July, 1951, giving full particulars of age, qualifications and experience and enclosing copies of not less than two recent testimonials.

G. D. SPEARING,
Clerk of the Council.

R.D.C. Offices,
Chepstow, Mon.,
20th June, 1951. E8977

PUBLIC NOTICES

CIVIL SERVICE COMMISSION

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

SENIOR PRINCIPAL SCIENTIFIC OFFICER

The Civil Service Commissioners invite applications for a vacancy for a SENIOR PRINCIPAL SCIENTIFIC OFFICER in the Building Operations Research Unit of the Building Research Station. The officer appointed will, for the present, be stationed in South Kensington, but it is expected that the Unit will eventually be transferred to the headquarters of the Building Research Station at Garston, near Watford, Herts.

The successful candidate will be expected to direct and take charge of staff engaged on the study of productivity and costs of building. This will include the application of research methods to the study of building processes and to site and factory operations.

All candidates must have been born on or before 1st August, 1916, and have a First or Second-Class Honours Degree in some branch of Science or Engineering or an equivalent qualification. Good experience in research is essential. Experience of operational research is a distinct advantage, although a lack of such experience would not preclude the appointment of an otherwise suitable candidate. Knowledge of statistical methods is an advantage.

Inclusive salary scale (London), £1500 by £75 to £1750 (men), £1340 by £75 to £1580 (women). Exceptionally a starting salary above the minimum may be granted according to qualifications and experience.

The post is superannuable under the Federated Superannuation System for Universities.

Further particulars and application forms from the Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S 4042/51. Completed application forms must be returned by 2nd August, 1951.

E9012

MINISTRY OF SUPPLY

INSPECTORATE OF ARMAMENTS

ENGINEER I

ENGINEER I needed by Ministry of Supply in the Inspectorate of Armaments, London. Qualifications and experience : recognised apprenticeship and either be Corporate Members of one of the Institutions of Civil, Mechanical or Electrical Engineers, or have passed examinations recognised by any of these Institutions as granting exemption from Sections " A " and " B " of their examinations for Associate Membership. Should have a good knowledge of the design of " special to contents " containers and be familiar with the latest P.I.P. methods in the packaging of Military stores to meet all climatic conditions ; experience of the preparation of specifications, knowledge of various methods of packing and types of materials involved and the testing of prototype packs. A sound knowledge of all types of armament stores an advantage. Duties : responsible to the Chief Inspector for inspection of all preservation, identification and packaging of armament equipments and stores (general policy, design and technical direction). Salary : £1050–£1270. Not established, periodical competitions for establishment.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, W.C.2, quoting C 363/51A. Closing date 31st July, 1951. E9009

MINISTRY OF SUPPLY

ROYAL AIRCRAFT ESTABLISHMENT

MECHANICAL ENGINEERS

MECHANICAL ENGINEERS are invited by the Ministry of Supply to apply for an unestablished appointment in the grade of Scientific Officer at the Royal Aircraft Establishment for research into the more fundamental aspects of the development of aircraft hydraulics, pneumatic and oxygen systems, involving problems of gas and liquid flow, control systems and storage. Candidates must possess a First or Second Class Honours Degree in Mechanical Engineering or Engineering Physics, and some works experience is desirable. Salary will be determined on age and on an assessment of the successful candidate's qualifications and experience within the range £380 to £620. Rates for women somewhat lower. Posts carry benefits of F.S.S.U.—Application forms obtainable from the Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, W.C.2, quoting Ref. C 354/51A. Closing date, 28th July, 1951. E9006

MINISTRY OF SUPPLY

MECHANICAL ENGINEERS

MECHANICAL ENGINEERS are invited by the Ministry of Supply to apply for an unestablished appointment in the grade of Scientific Officer in London headquarters, to originate and supervise research associated with mechanical engineering problems in the aero-engine industry and to represent the Ministry in committee work. Candidates must possess a First or Second Class Honours Degree in Mechanical Engineering. Experience of aero-gas turbines, preferably design and experimental test work, is necessary. Salary will be determined on age and on an assessment of the successful candidate's qualifications and experience within the range £400 to £650. Rates for women somewhat lower. Post carries benefits of F.S.S.U.—Application forms obtainable from Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, W.C.2, quoting C 340/51A. Closing date 28th July, 1951. E9008

PUBLIC NOTICES

COUNTY BOROUGH OF BIRKENHEAD

APPOINTMENT OF WATER ENGINEER

Applications are invited for the appointment of WATER ENGINEER to the Corporation at a commencing salary of £1250 per annum, rising, subject to satisfactory service, by three annual increments of £50 and one of £60 to £1460 per annum.

Applicants must be Chartered Civil Engineers and have had a wide and varied experience in a responsible position in the construction, operation and maintenance of large waterworks undertakings, preferably deriving their supplies from upland, underground and river sources, and in mechanical filtration plant and the construction of large aqueducts.

The successful candidate will be required to commence his duties as Water Engineer on the 8th April, 1952, when the present Water Engineer retires.

In the intervening period between the making of the appointment and the commencement of duties as Water Engineer, the gentleman appointed will be required to act as Assistant Water Engineer with the object of familiarising himself with the details of the undertaking. The salary whilst acting in this capacity will be at the rate of £1250 per annum.

The gentleman appointed will be required to devote the whole of his time to the duties of the office and to pay over to the Council any fees, premiums or payments of any kind whatsoever received by him in connection with the appointment.

The appointment will be terminable by three months' notice on either side and will be subject to the provisions of the Local Government Superannuation Act, 1937, and the successful candidate will be required to pass a medical examination.

Applications must be made on the official form, copies of which may be obtained from the office of the undersigned, and they must be received by him in sealed envelopes endorsed " Water Engineer " not later than 10 o'clock a.m. on Monday, the 16th July, 1951.

Canvassing, either directly or indirectly, will be regarded as a disqualification.

DONALD P. HEATH,
Town Clerk.

Town Hall,
Birkenhead,
June, 1951. E9028

RUGBY RURAL DISTRICT COUNCIL

CLIFTON-UPON-DUNSMORE SEWERAGE

CONTRACT NO. 7

APPOINTMENT OF RESIDENT ENGINEER

Applications are invited for the above appointment, to supervise the construction of sewers, rising main and pumping station.

The work will be executed by contract and will be under the direction of the Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 18, Queen Anne's Gate, Westminster, S.W.1. The salary will be £500 per annum plus a lodging and subsistence allowance of £150 per annum, if necessary.

It is anticipated that the appointment, subject to satisfactory service, will last approximately nine months and will be terminable by one month's notice in writing on either side.

Applicants, who should have had considerable experience of similar work, should apply in writing to the undersigned not later than 14th July, 1951, and the application should give full particulars of age, qualifications and experience and be accompanied by copies of not less than two recent testimonials.

Canvassing in any form will be deemed a disqualification.

H. A. WILDE,
Clerk of the Council.

Rugby Rural District Council,
Council Offices,
24, Warwick Street,
Rugby,
19th June, 1951. E8958

GOLD COAST

VOLTA RIVER HYDRO-ELECTRIC PROJECT

Applications are invited for the following vacancies on the staff of the Chief Civil Engineer.

THREE CHIEF ASSISTANT ENGINEERS.—One with irrigation experience. Salary up to £125 per month.

FOUR ASSISTANT ENGINEERS.—With experience of construction of roads, railways and/or water supply. Salary up to £90 per month.

ONE DRAUGHTSMAN/DESIGNER, preferably with experience of above types of civil engineering work. Salary up to £70 per month.

ONE FITTER MECHANIC for maintenance of transport, plant and equipment. Salary up to £70 per month.

ONE BUILDING FOREMAN for construction of permanent houses and camps. Salary up to £70 per month.

The above are maximum commencing salaries, the actual sums will be decided according to experience of successful candidates.

Free passages. Good leave between each tour, which will be of 18 months' duration.

Applications with particulars of qualifications and experience and references to previous employers to be sent to the Engineers, Sir William Halcrow and Partners, MM.I.C.E., Alliance House, Caxton Street, Westminster, S.W.1. E8988

For continuation of Small Advts., page 4

PUBLIC NOTICES

BOARD OF TRADE

DEVELOPMENT AREAS TREASURY ADVISORY COMMITTEE

ADVISORY OFFICERS

Board of Trade has immediate vacancies in Cardiff, Manchester, Newcastle-on-Tyne and Glasgow for ADVISORY OFFICERS in connection with Development Areas Treasury Advisory Committee. Work involves visits to firms who have applied to this Committee for financial help; inspection of organisation and management of their factories; examination of production methods from point of view of production engineer, and reporting on these matters. Candidates must be competent to examine plant lay-out, production methods and processes, planning and control. Posts are not pensionable, but employment for at least three years will be offered to suitable candidates after period of satisfactory service. Salary range is £1100–£1300. Starting pay determined according to qualifications and experience—Written applications, giving date of birth and education, full details of qualifications and experience of posts held (including dates), should be addressed to Appointments Officer, Ministry of Labour and National Service, 1–6, Tavistock Square, W.C.1, quoting Reference No. K.J.258, within fourteen days of appearance of this advertisement. In no circumstances should original testimonials be forwarded. E9007

MINISTRY OF FUEL AND POWER

CHIEF SCIENTIST'S DIVISION

SCIENTIFIC OFFICERS

Ministry of Fuel and Power invite applications for SCIENTIFIC OFFICERS in the Chief Scientist's Division, London, for fundamental and applied research on problems affecting the production and utilisation of fuel and power. The work includes the development of prototype installations in this field. Requirements are for (a) Chemical Engineers with knowledge of one or more branches of fuel technology, and (b) Mechanical Engineers with interest in applied physics. Qualifications: University Degree with First or Second-Class Honours in an appropriate subject, or equivalent. Ages: at least 21 and under 28 on 1st August, 1951. Salary is based on age and experience within the range £400–£650 per annum. Appointments are temporary in the first instance, but candidates may later compete for establishment.—Write for application forms to the Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.466/51/A. Closing date 31st July, 1951. E9027

HIS MAJESTY'S COLONIAL SERVICE, BRITISH HONDURAS

PUBLIC WORKS DEPARTMENT

EXECUTIVE ENGINEER

A vacancy has occurred in the Public Works Department, British Honduras, for an EXECUTIVE ENGINEER. Appointment will be on probation for permanent and pensionable employment at a salary of 3840 dollars per annum (£960 at current sterling equivalent of 4.00 dollars to the £1). A cost-of-living allowance of 144 dollars per annum is at present payable. Local government superannuation rights can be preserved.

Conditions of service include free passages on appointment for the officer, his wife and children, not exceeding four in all, and on leaves for the officer and his wife; home leave on full pay at the rate of five days for each month of resident service; tours of two to three years approximately.

Candidates should be under 40 and should be A.M.I.C.E. or exempt from Sections "A" and "B" of the A.M.I.C.E. examinations. They should have had some years' practical experience on civil engineering work.

For a form of application write, giving brief particulars of age, qualifications and experience, to the Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1. Please mention this paper and quote No. 27322/138. E9015

CITY OF NOTTINGHAM

WATER DEPARTMENT

APPOINTMENT OF CIVIL ENGINEERING ASSISTANT (PERMANENT)

Applications are invited for the appointment of CIVIL ENGINEERING ASSISTANT at a salary in accordance with Grade A.P.T. IV of the National Scale, commencing at £530 per annum, rising by annual increments of £15 to £575.

Candidates should be not more than 45 years of age, must possess an Engineering Degree, and should have had experience with a water undertaking, a firm of consulting engineers, or in the engineer and surveyor's department of a local authority.

The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, and the successful candidate will be required to pass a medical examination.

Applications, stating age, qualifications and experience, and giving names of two persons to whom reference can be made, should be enclosed in an envelope endorsed "Civil Engineering Assistant—Water Department," and delivered to me not later than Monday, the 16th July, 1951.

T. J. OWEN,
Town Clerk.

The Guildhall,
Nottingham. E9002

PUBLIC NOTICES

BRITISH ELECTRICITY AUTHORITY

SOUTH-EAST SCOTLAND DIVISION

SENIOR CIVIL ENGINEERING DRAUGHTSMAN

Applications are invited for the position of SENIOR CIVIL ENGINEERING DRAUGHTSMAN, Grade 5, in the Department of the Generation Engineer (Construction) at Portobello.

Applicants should hold a University Degree or equivalent qualification and be experienced in the design and construction of civil engineering works.

The salary for the appointment, which is superannuable, will be within the range £500–£600 per annum, according to qualifications and experience.

Applications, stating age, qualifications and experience, should be addressed to the Divisional Controller, British Electricity Authority, South-East Scotland Division, British Electricity House, Portobello, Edinburgh, not later than Monday, 9th July, 1951.

J. F. FIELD,
E8997 Divisional Controller.

WEST SUSSEX COUNTY COUNCIL

COUNTY ARCHITECT'S DEPARTMENT

Applications are invited for the following appointments at salaries in accordance with the National Scales of Salaries:—

(a) SENIOR ASSISTANT ARCHITECT, Grade VIII A.P.T. Division (£735 to £810 per annum).
(b) SENIOR ASSISTANT ARCHITECT, Grade VI A.P.T. Division (£645 to £710 per annum).
(c) ASSISTANT MAINTENANCE INSPECTOR-ENGINEER, Grade III A.P.T. Division (£500 to £545 per annum).

Further particulars should be obtained from the County Architect, County Hall, Chichester, to whom detailed applications must be submitted not later than Tuesday, 17th July, 1951.

T. C. HAYWARD,
Clerk of the County Council.

County Hall,
Chichester,
19th June, 1951. E9001

COMMONWEALTH TECHNICAL CO-OPERATION SCHEME

COMMONWEALTH RELATIONS OFFICE

EXPERT DESIGNING ENGINEER

Applications are invited by the Commonwealth Relations Office for the post of EXPERT DESIGNING ENGINEER under the Government of India, in India, at a salary of £3000 to £3500 per annum, plus subsistence allowance, travelling facilities and free medical attention. Other facilities, including those for families, to be discussed. Applicants, preferably between the ages of 45 and 50, should be Corporate Members of the Institution of Civil, Mechanical or Electrical Engineers, and must have considerable experience in the design of extra high-tension transmission lines, including tower structures. The selected applicant will be responsible to the Chairman, Central Waterpower Irrigation and Navigation Commission, for the mechanical and electrical design of such transmission systems as will be required for grid supply connecting super-hydro power stations and long-distance power transmission projects. He will be expected to guide and train the Indian engineers under his control. The contract is for two years in the first instance. Forms of application may be obtained from the Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, W.C.2, quoting D 280/51/A.0. Closing date 28th July, 1951. E9005

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A CHIEF PLANNING ENGINEER with experience of operational planning, jig and tool design, sheet metal manipulation, plant lay-out and modern machine tools technique is required, Frigidaire Division of General Motors, Ltd. The post is a progressive one and offers considerable scope to the right man.—Application, which should state age, experience and salary required, should be made to the Personnel Manager, Frigidaire, Stag Lane, N.W.9. E8967 A

A DRAUGHTSMAN-DESIGNER, of British birth, not over 35, with sound experience of steam utilisation for industrial purposes, is offered a well-paid, progressive position and, if married, a house on a rental basis after a short probationary period, during which time a subsistence allowance will be given. Candidates should be of at least H.N.C. standard and should have had practical workshop training. All applications treated in strict confidence.—Write, EP, Michelin Tyre Co., Ltd., Stoke-on-Trent, Staffs. E1422 A

A GRADUATE ELECTRICAL Engineer under 40 years of age, with a minimum of five years' experience in design and operation of modern power generation, transmission and distribution equipment, is required by the Bahrein Petroleum Company, Ltd. The living costs are low, the Company providing free board, air-conditioned accommodation and medical attention. A pension scheme is in operation and a kit allowance is given for initial tour. Agreements are for two years, with paid local and home leaves.—Write, with full particulars of age, experience and salary required, to BOX 4158, c/o. Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E433 A

SITUATIONS VACANT

A CIVIL ENGINEER, building maintenance; Senior Consultant Production Engineer; Machine Shop Superintendent, also Materials Controller (South Coast); Maintenance Engineer, single preferred, 29/35 (Scotland); Mould Toolmaker (South Africa); Draughtsmen and Tracers, all types of industries; Mining Engineer (overseas); Crane Inspectors; Boiler Surveyors; other situations vacant.—Write in confidence, Technical Employment Agency, 179, Clapham Road, S.W.9 (BBIxton 3487). E348 A

A LARGE AIRCRAFT FACTORY requires a senior Machine Tool Draughtsman. Applicant should have served recognised apprenticeship, preferably with machine tool firm, and be capable of designing a wide range of special purpose machines. Permanent, interesting staff appointment.—BOX No. E1446, "The Engineer." A

A MECHANICAL ENGINEER is required by a major British Oil Company for service in the Middle East on maintenance of turbo-driven pumps from 100 h.p. to 3000 h.p., turbo-driven alternators from 500 to 3000kWs and gas combustion turbine-driven alternators. Applicants must have served a full mechanical engineering apprenticeship with one of the leading manufacturers of turbines and have had experience in the turbine test room on motor balancing. Experience of outside erection of turbines from 100 to 10,000 H.P. is required. Higher National Certificate in Mechanical Engineering is essential. Age limit 35 years.—Write, giving personal particulars and full details of qualifications and experience, quoting Dept. F.51/F, to BOX No. 3921, at 191, Gresham House, E.C.2. E8848 A

A NUMBER of suitably, qualified Designer-Draughtsmen are required by a well-known company engaged on gas turbine development in the Liverpool area. The work entails design of compressor and turbine units, models and associated test rigs. Applicants should write, giving the fullest details of their qualifications and experience, quoting Ref. AGJ.—BOX No. E8946, "The Engineer." A

A WELL-KNOWN COMPANY requires Junior Engineers for their steam turbine division in the Midlands. Applicants should have good drawing-office experience and a background of practical engineering, preferably directly connected with steam turbines. Please write, stating age, experience and qualifications, quoting Ref. HJD (1).—BOX No. E9038, "The Engineer." A

A WELL-KNOWN FIRM in the London area requires Designers and Designer-Draughtsmen. Suitably qualified men with internal combustion engine design experience are invited to apply for these permanent and progressive positions. Applicants should write, giving the fullest information, mentioning ref. CDF.—BOX No. E8932, "The Engineer." A

A WELL-KNOWN manufacturer has a vacancy for an experienced Contracts Engineer to cover comprehensive tenders dealing with heavy mechanical and electrical plant. This is a permanent appointment, offering very good prospects. Salary up to £750 per annum, according to qualifications and experience.—Write, giving full details of age, education and previous experience, mentioning Ref. IJH, to BOX No. E8990, "The Engineer." A

A WELL-KNOWN WEST MIDLAND Engineering Company, manufacturers of two and four-stroke internal combustion engines, are in need of a first-class Designer Engineer for magneto design. Suitably qualified men with a sound technical knowledge in the manufacture and design of magnetos are invited to apply. Write, in confidence, giving details of age, previous experience and salary required; endorse envelope "Personnel Department."—BOX No. E1461, "The Engineer." A

AIRCRAFT STRESSMEN required. — Write stating qualifications and experience, to Employment Manager, Vickers-Armstrongs, Limited (Aircraft Section), Weybridge. E8099 A

AMBITIOUS MEN with suitable experience are invited to apply for posts as Senior Design Engineers with the steam turbine division of a well-known company in the Midlands. Excellent salary and prospects of promotion are offered in a department which is expanding and working on advanced design and development in this field. Please write, in confidence, giving full details of experience and qualifications, quoting Ref. HJD.—BOX No. E9017, "The Engineer." A

AN ENGINEER, with a good Degree and workshop experience, is required by a nationally known company. The position involves managerial responsibilities, supervision of maintenance work and the handling of technical problems arising from the installation and operation of modern chemical and mechanical equipment. Graduates of 23–28 years of age with the necessary experience will be interested in this opportunity of joining a progressive company with an excellent record of growth and development. The successful applicant will be given careful training for an adequate period before taking up his initial responsibilities, which will be clearly defined. All senior positions are filled from within the company, and it is hoped that the successful applicants will be capable of early development into greater responsibilities as the company grows. An excellent commencing salary will be offered and generous increments will match the candidate's progress. Applications will be treated in strictest confidence. Please forward a short outline of background, &c.—BOX No. E9061, "The Engineer." A

AN OLD ESTABLISHED light engineering public company with works in London, employing 1300 workpeople (50 per cent female) and 150 office and sales staff, invites applications from engineers aged 35–45 for the post of Assistant to the Managing Director. Applicants must be of good address and strong personality, with practical sales outlook and experience. Experience in batch production of small parts and sound knowledge of automatics essential. A minimum commencing salary of £2000 per annum is offered for this progressive appointment, leading to early appointment of General Manager and, later, to the Managing Directorship at commensurate remuneration. Applications, which will be treated in strict confidence, should give full details of education, qualifications, posts held, numbers of workpeople and staff controlled and salaries earned.—Write, quoting FBS/1062, to BOX No. 8228, c/o. Whites' Ltd., 72/8, Fleet Street, E.C.4. E8996 A

SITUATIONS VACANT

AN IMPORTANT London company requires Senior Mechanical Draughtsman for work covering a wide range of special purpose machinery. Applicants should have good general engineering experience and be educated to Higher National Certificate standard. Starting salary will be between £A.E.S.D. rate and £550 per annum, according to age, qualifications and experience.—Applications should state age and include full details of education and career to date.—Write BOX "M," c/o. J. W. Vickers and Co., Ltd., 7/8, Great Winchester Street, E.C.2. E9

APPLICATIONS are invited from Draughtsmen and Stressmen, also Technical Assistants, with combined design and performance experience, to work on both reciprocating and turbine aero-engines.—Applications should give full particulars of experience and qualifications and should be addressed to the Personnel Manager, The de Havilland Engine Co., Ltd., Stonegrove, Edgware, Middlesex. E1

APPLICATIONS are invited for position of Works Manager in large constructional and general engineering works. Applicants who have served works apprenticeship preferred, but first-class qualifications and practical shop experience in heavy structural and platework industry essential. Salary commensurate with duties and responsibilities. Pension scheme.—Apply, giving particulars of qualifications and experience, and age, to the Secretary, The Tees Side Bridge and Engineering Works, Ltd., Middlesbrough. E1

APPLICATIONS are invited for the new post of Assistant Chief Engineer of a modern heavy chemical works producing caustic soda, chlorine, hydrochloric acid, &c., by electrolytic methods. Experience in design and development is essential and previous knowledge of the industry and modern methods of engineering organisation and planning would be recommendations. Pension and housing scheme.—Please reply, in confidence, giving full particulars, to BOX No. E1448, "The Engineer." A

ASSISTANT ENGINEER required for development work on medium light special purpose machinery. Candidate must have drawing office and works experience, and must be capable of accepting responsibility. Higher National Certificate or equivalent necessary. Knowledge of glass and glass machinery would be helpful. Good salary and permanent post for right man.—BOX No. E437, "The Engineer." A

ASSISTANT ESTIMATING ENGINEER required by manufacturing mechanical engineers, South Hampshire. Experience batch production of machines ¼ cwt. to ½ ton advantageous. Must be willing and energetic and have served an indentured apprenticeship with a reputable company. 0.S. of value, but not essential; age about 30. Salary £350–£450, according to experience. Promotion possible later if satisfactory. Apply, giving full particulars.—BOX No. E1470, "The Engineer." A

ASSISTANT ESTIMATOR/Planning Engineer for heavy engineering shop. Good practical experience and a knowledge of modern methods essential. Give full details in reply and state salary required.—Write BOX No. E8878, "The Engineer." A

ASSISTANT General Manager required for moderate-sized but rapidly expanding London engineering company, specialists in hydraulic equipment and centralised lubrication. Post carries responsibility for control of production (mainly sub-contracted) and its co-ordination with sales and design depts. Applicants must be competent mechanical engineers with previous experience at this level. Post offers prospects in man of initiative, able to get results. Commencing salary £850.—State full details of training, experience and age to BOX No. 635, c/o. George Murray (Advt.), Ltd., 184, Strand, London, W.C.2. E8860 A

ASSISTANT MECHANICAL ENGINEER possessing Hons. Degree, required for investigation and development work in engineering dept. of large textile company in West Riding. The appointment calls for exceptional ability in the accurate assessment and logical interpretation of investigations into boiler and prime mover efficiencies, steam utilisation and heat balances, electrical plant load factors and efficiencies, and other connected processes, at the branch factories of the company. Previous experience in similar work an advantage; age 25/30. The prospects are good and an adequate salary will be paid.—Address, with full details age, qualifications, experience and present salary, BOX No. E1468, "The Engineer." A

ASSISTANT PLANT ENGINEER required, aged 25/30 years, for West London factory; knowledge heavy presses, electrical installations and training in general factory maintenance essential.—Write, stating age, experience and salary required, to BOX E 111, L.P.E., 110, St. Martin's Lane, W.C.2. E9057 A

ASSISTANT PLANT ENGINEER required by modern plant, N.W. London. Previous experience in a similar capacity and good knowledge of machine tool work essential.—Reply, stating age, experience and salary expected, to Personnel Manager, Frigidaire Division of General Motors, Ltd., Stag Lane, N.W.9. E9016 A

ASSISTANT TO MANAGING DIRECTOR —Applications are invited for qualified Mechanical Engineer, A.M.I.Mech.E., or equal, with commercial experience and of proved ability as Assistant to Managing Director. Only those who are energetic, enthusiastic, say, 40 years of age, and with responsible executive experience need apply. Knowledge of mining machinery and/or paper-making machinery and/or diesel railcars is an advantage.—Full details, in confidence, to Managing Director, Walker Brothers (Wigan), Limited, Wigan, Lancs. E1449 A

ASSISTANT WORKS MANAGER required for large engineering works, comprising machine shops, fabricating shop, press shop and large ironfoundry, situated in the North of England and employing about 1500. Products include earth-moving equipment, mining machinery, machine tools, heavy castings and various general engineering work. It is essential that applicant should have experience in medium/heavy plant and be well versed in modern production methods. They should, preferably, possess University Degree in Engineering or equivalent, and be 30 to 40 years of age. The successful applicant may be required to visit America for short periods. The firm has a pension scheme in operation, and a good salary will be paid, to the right man.—BOX No. E1469, "The Engineer."

SITUATIONS VACANT

ASSISTANT Time Study Engineer required by British Cellophane, Limited, Bridgwater, Somerset; age 25/35. Must have had engineering workshop experience (preferably as an apprentice) and obtained Ordinary or Higher National Certificate.—Write, giving full details and salary required, to the Personnel Officer. E8948 A

BELLISS AND MORCOM, LTD., Birmingham, have vacancies for Reciprocating Engine Draughtsmen having good design experience with any of the following :—Steam engines, oil engines, air compressors. Interesting work with good prospects for suitable applicants. Write, stating age, experience, salary required, &c. E1464 A

BRITISH OXYGEN Co. require Honours graduate in Chemical Engineering or Allied Science, with at least five years' experience on the production side of the chemical or process industries for chemical work connected with production of industrial gases.—Apply, giving full details of age, qualifications and experience, to Bridgewater House, Cleveland Row, St. James's, S.W.1. E8999 A

BRITISH OXYGEN Co. has vacancies in this country and overseas for Engineers. Applicants should be aged 22/30 and Graduates in Mechanical Engineering, or hold equivalent qualifications. Would preferably have one or two years' industrial experience. These posts offer very good salaries.—Apply, giving full details of age, qualifications and experience, to Bridgewater House, Cleveland Row, St. James's, S.W.1. E9074 A

BUYER wanted for all eng. materials for the manf. of machine tools.—F. J. Edwards, Ltd., 359, Euston Road, London, N.W.1. E8976 A

CANADA NEEDS ENGINEERS.—Members of all branches of the profession required by great number of industries, educational institutions, municipalities and Government agencies. The Engineering Institute of Canada is endeavouring to find persons to fill these openings. Are you interested ? The General Secretary of the Institute, Mr. Austin Wright, will be in England by June 21st to interview interested parties. He will give information on openings, working conditions, salaries, transportation, &c. Address, care of Institution of Civil Engineers, Great George Street, London, S.W.1. Issued under the authority of the Department of Citizenship and Immigration, Ottawa, Canada. E9021 A

CATERPILLAR TRACTOR Co., Ltd., Coalville, Leicester, require an Assistant Buyer, age between 25 and 35, and preferably with experience of the motor or light engineering industry. Replies, which will be treated in confidence, should state age, experience and salary required. E1450 A

CHEMICAL ENGINEER required for technical sales office of well-known engineering organisation in London area with some experience of preparation of schemes and tenders and with knowledge of hydraulics ; age 22 to 30. Write, stating experience, qualifications and salary required.—BOX No. 8404, "The Engineer." A

CHEMICAL ENGINEER, to be responsible for the design and construction of metallurgical plant. Knowledge and experience of high-vacuum technique essential. First-class position with leading company and excellent prospects offered. All information, which should be detailed, will be treated in strict confidence.—BOX No. E1402, "The Engineer." A

CHEMICAL MANUFACTURERS in London area require Senior Draughtsmen (age over 35 years) and a Draughtsman (age 25–35 years). Experienced design and lay-out, chemical or allied plant and pipework requirements. Salary according to qualifications and experience. Contributory pension scheme.—Apply initially in writing, giving full details and quoting BOX No. E8771, "The Engineer." A

CHIEF DESIGNER required immediately for Glasgow engineering works. First-class experience in the design of high-pressure and temperature steam power plant is essential. Must be able to create original designs for hydraulic and steam control apparatus. Only men capable of earning four-figure salary need apply. State age, technical and practical experience, positions held and salaries earned.—BOX No. E1419, "The Engineer." A

CIVIL AND STRUCTURAL Engineering Draughtsmen required by chemical engineering contractors in East London area. Good prospects, staff pension scheme.—BOX No. E8950, "The Engineer." A

CIVIL, ARCHITECTURAL and Mechanical Draughtsmen required by a major oil company ; age 23 to 35. Write, stating experience and salary required.—BOX No. E1474, "The Engineer." A

CIVIL ENGINEER, age 30–40, required for Plateau, Nigeria, to superintend erection pipe-line and construction power-house, 4000kW, 400ft. head, also new apron spillway to earth dam ; eighteen months' engagement, salary £80 per month.—BOX No. E1404, "The Engineer." A

CIVIL ENGINEERING ASSISTANTS and Draughtsmen required with experience of design of cast iron tunnels. Apply at once, with particulars of qualifications and experience, and references to previous employers.—BOX No. E9020, "The Engineer." A

CIVIL ENGINEER required by firm of consulting engineers. Applicants should have a good knowledge of heavy foundations, steelwork, industrial buildings, drainage, such as are met with in large industrial plants. Applicants should have passed Sections A and B of the A.M.I.C.E. examination. They should be prepared to live abroad for two or three years if required, be preferably unmarried, and between 30 to 35 years of age.—BOX No. E1433, "The Engineer." A

CIVIL ENGINEERS and Contractors require a qualified Civil Engineer with wide technical and site experience on large-scale contracts as Agent for a long-term project near Wolverhampton. Sound knowledge of reinforced concrete and general building, good organiser and administrator and ability to produce first quality work essential. Duties include direct collaboration with clients and successful applicant will find an attractive position with salary according to qualifications. Bonus scheme in operation. Write age, experience, salary, when free.—BOX No. E1442, "The Engineer." A

CIVIL ENGINEER, with at least seven years' experience in the design of harbour works, heavy masonry structures and preparation of quantities, required by consulting engineers in Westminster. Apply, stating age, experience and salary required. —BOX No. E1454, "The Engineer." A

CONSTRUCTIONAL ENGINEERS, Medium size, Middlesex, require Man with necessary practical experience, up to control works and outside erection ; pension fund. Full particulars, age, and salary required.—BOX No. E1459, "The Engineer." A

CONSULTING ENGINEERS, Park Lane area, require Detailing Draughtsman for reinforced concrete or structural steelwork. Good salaries offered to experienced applicants ; five-day week. Apply, stating age, experience and salary required. —BOX No. E1471, "The Engineer." A

CONTRACTS ENGINEER—for large valve and pump tenders and contracts with knowledge of B.E.A. and similar work. Preferably with drawing office experience. Must be responsible, accurate and capable of taking full charge of a contract throughout. Salary according to age, ability and experience.—Sir W. H. Bailey and Co., Ltd., Albion Works, Patricroft, Lancs. E1399 A

COURTAULDS LIMITED, Coventry, Chemical Engineering Section, require Draughtsmen for design of chemical plants and development work, including instruments. Experience of chemical plant is desirable but not essential as work covers a wide range. Consideration will be given to all applicants with satisfactory technical training but candidates should preferably hold a Higher National Certificate in Engineering. E8993 A

DE HAVILLAND ENTERPRISE at Hatfield, Herts. Vacancies for Draughtsmen and Specification Technicians as under : (H) Senior Jig and Tool Draughtsmen—preferably experience in aero engineering. (K) Senior Draughtsman experienced in aircraft electrical installation and details. (L) Senior Draughtsmen—experienced in aero engines or auxiliaries, of 5 years light internal combustion engines. (M) Senior Draughtsman—5 years' experience in aircraft drawing office, for D.I.S., with full knowledge of procedure. (N) Junior/Intermediate Draughtsmen—2 to 3 years' drawing office experience essential. (P) Specification Writers—experience essential either in similar capacity or aircraft drawing office or aircraft works technical department. Ability to write technical matter clearly in good English necessary. (Q) Specification Writer for junior position. Opportunity for advancement for man of good education and some aero engine experience. Ex R.A.F. man preferred. Permanent, progressive posts to keen, ambitious men.—Write, giving details of education, technical training and experience in previous employment to Personnel Manager, de Havilland Propellers, Ltd., Hatfield, Herts. Satisfactory references will be required. Travelling expenses paid to candidates selected. E8882 A

DESIGNER-DRAUGHTSMAN required for London Head Office and/or site offices of old-established firm of reinforced concrete engineers, specialising in hollow tile type floor construction. Progressive post. Write fully qualifications and salary required.—BOX No. E8957, "The Engineer." A

DESIGNER DRAUGHTSMAN with Higher National and some years' responsible experience of general engineering and machine design work.—Apply in writing to Personnel Dept., Telegraph Construction and Maintenance Co., Ltd., Telcon Works, Greenwich, S.E.10. E8879 A

DESIGNER (aged 25–32), with experience of basic design of specialised steam plant and equipment ; knowledge of fluid flow and heat transfer desirable. Workshop training and not less than five years' drawing-office experience essential. H.N.C. or above.—Write fully to BOX 4979, c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E8745 A

DESIGNER DRAUGHTSMAN (age 30/35) required for diesel engine design work, preferably with some 2-stroke experience. Permanent position, five-day week, staff pension scheme. East Midland district.—Apply, stating age, experience, and salary required, BOX No. E1401, "The Engineer." A

DESIGNER for mass production jig and tools required for light electrical product. Indentured apprenticeship and at least five years' designing experience essential.—Write, giving age, details of experience and salary required, to Personnel Manager, Standard Telephones and Cables, Ltd., Warwick Road, Boreham Wood. E8943 A

DESIGNERS, with experience of commercial and passenger vehicle chassis, diesel engines, and vehicle transmissions, &c., required by A.E.C., Limited, Southall, Middlesex. Applications in writing to Staff Records Office, stating age, experience and salary required. E8756 A

DESIGNER DRAUGHTSMAN (age 30/50 years) required to take charge of small drawing-office in light engineering works. Must be fully experienced and qualified technically to degree standard ; mainly mechanical engineering, but sound electrical knowledge essential. South London district.—BOX No. E402, "The Engineer." A

DESIGNER-DRAUGHTSMEN, with Higher National Certificate, University Degree or similar qualifications and with two to four years' experience, are required for work with experimental research teams in mechanical and radio engineering. —Applications, giving age and record, should be sent to the Staff Manager (Ref. GBLC/436), Research Laboratories of The General Electric Co., Ltd., East Lane, North Wembley, Middlesex. E9050 A

DESIGN ENGINEER required by successful old-established company in the North of England, engaged particularly in the manufacture of heavy-duty D.C. switchgear. He should have scientific and commercial qualifications as well as practical experience, originality and initiative. He would have unlimited opportunity for developing his ability at a good salary, rising without limit according to his performance. To the right man the future prospects are bright.—BOX No. E1279, "The Engineer." A

DETAIL DRAUGHTSMEN required for hydraulic equipment. Previous drawing-office experience on good-class engineering necessary. Good conditions and prospects ; permanency for right men.—Write, giving full particulars, to Chief Engineer, BOX 652, c/o Geo. Murray (Advertising), Ltd., 184, Strand, London, W.C.2. E9066 A

DETAIL DESIGN DRAUGHTSMAN required by firm of engineering consultants. Experience in one or more of the following :—Power station lay-outs, industrial furnace and chemical plant, structural steelwork experience an advantage. Opportunities will be given for gaining experience in other fields. Good conditions of service and contributory pension scheme.—Write, giving full details of qualifications, experience, age and salary required, to Chief Engineer, Powell Duffryn Technical Services, Ltd., 19, Berkeley Street, London, W.1. E9076 A

DEVELOPMENT DESIGNERS and Draughtsmen required by the Plessey Company, Limited. Applicants would be required to undertake the design of tools and equipment, including plastic and die casting tools, and the subsequent development to production stage of small electro-mechanical devices. The posts are permanent and offer variety and interest. — Write, stating age, experience and salary required, to Mr. C. D. H. Webb, General Divisional Manager, Breeze Electrical Division, Plessey Company, Limited, Ilford, Essex. E9047 A

DOWSETT Engineering Construction, Limited, have a number of vacancies for Assistant and Junior Engineers. It is essential that applicants are either fully qualified or in process of obtaining their qualifications, and it is necessary for Assistant Engineers to have had at least two years' practical experience after their technical training. The appointments in the first place will be on various civil engineering contracts in the British Isles, and there will be opportunity for transfer to the Company's Australian Associated Company engaged on major works in Australia for those who may wish to go abroad and after a preliminary period in this country have proved themselves thoroughly suitable for transfer. Adequate salary and expense allowances are paid and applicants should apply in writing, in the first place, giving full details of age, technical qualifications, practical training, past and present employers, and salary level, to Dowsett Engineering Construction, Ltd., Tallington, Stamford, Lincs. E1431 A

DRAUGHTSMAN, experienced in steam or diesel locomotive work, required by works in N.E. England. Permanent position to suitable man. Pensions scheme, &c.—Apply, BOX No. E1449, "The Engineer." A

DRAUGHTSMAN, experienced in design and lay-out of chemical and industrial plant, required for London office of chemical manufacturers. Please state age, experience and salary required.—BOX No. E9023, "The Engineer." A

DRAUGHTSMAN with petrol and diesel marine engineering experience required immediately by well-known south coast company. Age about 24.—Full particulars and salary required to BOX No. E8973, "The Engineer." A

DRAUGHTSMAN reqd., exp. in light, medium and heavy machine design and detailing ; London area. State salary and when disengaged.—BOX No. E9068, "The Engineer." A

DRAUGHTSMAN.—Senior Mechanical Engineer required ; good prospects to suitable man.—Apply in writing, stating age, experience and salary required, to Personnel Manager, Parsons Chain Co., Ltd., Stourport-on-Severn. Also Junior Draughtsman, approx. age 23/24. E1502 A

DRAUGHTSMAN required, with knowledge of heat exchange apparatus for distillation plants and other boiler feed auxiliaries for marine and industrial installation.—Write full details, Caird and Rayner, Ltd., 777, Commercial Road, London, E.14. E1504 A

DRAUGHTSMAN, age 25 to 35, with good all-round experience, accustomed to plant lay-out and general development work ; permanent position ; voluntary pension scheme ; house available if required.—Written applications, stating full details of technical qualifications and experience in chronological order, marked "Confidential," should be addressed to Engineering Director, John Smith's Tadcaster Brewery Co., Ltd., Tadcaster, Yorkshire. E1486 A

DRAUGHTSMAN required for design and/or detailing for structural steelwork, including bridges, buildings, gasholders and vessels of all descriptions. Positions offer exceptional experience in all classes of constructional engineering. Canteen and excellent working conditions. Five-day week.—Particulars and salary required to Personnel Manager, Horseley Bridge and Thomas Piggott, Ltd., Tipton, Staffs. E392 A

DRAUGHTSMAN required, experienced in design and lay-out of water treatment plant. Canteen and excellent working conditions. Pension scheme. Five-day week and sports facilities available.—Particulars of previous experience and qualifications, if any, to Personnel Manager, Horseley Bridge and Thomas Piggott, Ltd., Tipton. E8825 A

DRAUGHTSMAN (Junior), preferably with pump experience, in London area. — Apply, Gwynnes Pumps, Limited, 64, Chancellors Road, Hammersmith, W.6. E1368 A

DRAUGHTSMAN/DESIGNER required for firm 15 miles west of London. Experienced in design of small mechanisms. Salary £500 per annum approximately, depending on experience and qualifications. Permanent position.—BOX No. E8838, "The Engineer." A

DRAUGHTSMAN (MECH. ENG.) required for precast concrete factory at Iver, Bucks. Knowledge of reinforced concrete design an advantage but not essential. Salary, £350–£450 per annum, according to experience and ability.—Apply in own handwriting to BOX No. E1451, "The Engineer." A

DRAUGHTSMAN (SENIOR) required for light alloy organisation. Jig and tool experience, practical and design essential. A.E.S.D. rates up to 25 years. Over according to ability.—Apply in person, or by letter, to the Personnel Manager, High Duty Alloys, Ltd., Slough, Bucks. E8881 A

DRAUGHTSMEN (Intermediate and Senior grades) required at Brentford, London, with sound experience of small mechanical or electro-mechanical mechanisms. Good salaries, also lodgings available for single men.—BOX No. E8873, "The Engineer." A

DRAUGHTSMEN required for experimental and research work in mechanical engineering and aircraft design ; H.N.C. standard ; A.E.S.D. rates. —Tiltman Langley Laboratories, Ltd., Redhill Aerodrome, Surrey. E1485 A

DRAUGHTSMEN required for fabricating department drawing office. Experience in design of welded pressure vessels and general welded fabrications desirable but not essential. Excellent working conditions with canteen and sports ground.—Apply BOX No. E8859, "The Engineer."

DRAUGHTSMEN needed for the following departments, men having Higher National Certificate and qualified training preferred :—(a) Experienced in shell boiler design, boiler plant lay-out, brickwork settings, pipework, &c.; (b) experienced in structural steelwork design, i.e., bunkers, general platework and structural work in connection with boiler installations ; (c) for industrial plant department, experienced in pressure vessel design, welded or riveted, conversant with construction of oil refinery equipment and knowledge of American Standards an advantage ; (d) for works engineering department, experienced in factory lay-out and services, including steam, water, hydraulics, &c. Salary commensurate with ability, interesting work, good conditions, canteen facilities ; permanent position for right men. Staff superannuation scheme.—Particulars of technical education, experience, age and salary required, to Chief Engineer, Edwin Danks and Company (Oldbury), Limited, Oldbury Boiler Works, near Birmingham. E9073 A

DRAUGHTSMEN with sound electrical engineering experience (all classes) required for extremely interesting work in our Bath offices. Above A.E.S.D. rates to experienced applicants. Lodgings available for single men.—BOX No. E8874, "The Engineer." A

DRAUGHTSMEN required by well-known precision engineering firm in Middlesex, for design of press tools, jigs and fixtures. Must have practical engineering training and wide experience of tool design.—Write, with full details of experience, age and salary required, to BOX 6035, Frost-Smith Advg., 64, Finsbury Pavement, E.C.2. E8974 A

DRAUGHTSMEN required by well-known precision engineering firm in Middlesex, with experience in detailing small mechanisms for large-scale production.—Write, with full details of experience, age and salary required, to BOX 6039, Frost-Smith Advg., 64, Finsbury Pavement, London, E.C.2. E8975 A

DRAUGHTSMEN.—First-class Mechanical Designers are required by a large and progressive manufacturing company in the Midlands. Electrical experience and a knowledge of large quantity production methods is an advantage. Secure positions are offered for men with initiative and a flair for small mechanisms. Exceptionally high salaries will be paid to really first-class men. Please give details of experience, qualifications and age.—BOX No. E425, "The Engineer." A

DRAUGHTSMEN with the following experience required for work in our Bath offices : (a) diesel engines and auxiliary plant ; (b) hydraulic engineering ; (c) pumps, auxiliary machinery and light cranes ; (d) sheet metal equipment. Good wages paid, lodgings available for single men.—BOX No. E8876, "The Engineer." A

DRAUGHTSMEN : Several Structural Detailing Draughtsmen required. Salaries paid commensurate with experience and ability. Pension scheme.—Write, stating age, experience and salary required, to Dawnays, Ltd., Steelworks Road, Battersea, S.W.11. E1400 A

DRAUGHTSMEN required for large chemical factory in North Manchester. Experience in plant maintenance and development essential. Apply, stating age, qualifications, positions held, and salary required.—BOX No. E8798, "The Engineer." A

DRAUGHTSMEN, experienced, shop lay-outs, air, water, gas services, &c.; buildings, heavy plant foundations, mechanical handling, &c., for expansion programme. Apply, stating age, experience, &c.—BOX No. E432, "The Engineer." A

DRAUGHTSMEN, Senior and Junior, for design and detailing of commercial and passenger vehicle chassis, units and components, required by A.E.C., Limited, Southall, Middlesex. Applications in writing to Staff Records Office, stating age, experience and salary required. E8754 A

DRAUGHTSMEN & DESIGNER Draughtsmen with good engineering experience wanted immediately for work on textile machinery. Good salaries paid. Also required, Junior Draughtsmen ; textile experience not essential.—Apply, Personnel Manager, Platt Bros. and Co., Ltd., East Works, Bower Street, Oldham. E382 A

DRAUGHTSMEN AND ENGINEER Designers required for traction control gear. Men having good mechanical experience would be considered. Good remuneration for men of first-class experience.—Apply, quoting "Switchgear," to Staff Manager, The General Electric Co., Ltd., Witton, Birmingham, 6. E8907 A

DRAUGHTSMEN.—Marine engineering firm on Clydeside requires Senior Draughtsmen with design experience of (a) marine water-tube boilers, (b) marine turbines, or (c) pipe arrangements. Financial assistance given for house purchase, if required. Pension scheme in operation.—Write, stating age and giving particulars of previous experience, to BOX K.209, c/o Streets, 110, Old Broad Street, E.C.2. E8936 A

DRAUGHTSMEN required by The British Society for Research in Agricultural Engineering. The work includes design of prototype machinery and testing apparatus, and candidates should have experience in good-class general mechanical engineering. Minimum professional qualifications : Higher National Certificate, works training desirable. Salary in the following scales :—Draughtsman, £283 to £394 on entry, rising to £495 ; Leading Draughtsman, £470 by £20 to £595. These rates will probably be increased in the near future.—Apply to Secretary, N.I.A.E., Wrest Park, Silsoe, Beds. E1473 A

DRAUGHTSMEN required, with experience in one or more of the following :—Earth-moving machinery and equipment, gearbox and industrial gear transmission design, general mechanical engineering, jig and tool design, mine car design. Permanent situations and good working conditions ; five-day, 37½-hour week, canteen facilities, pension fund.—Applications, stating experience and salary required, to Distington Engineering Company, Limited, Chapel Bank Works, Workington, Cumberland. E1302 A

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SITUATIONS VACANT

DRAUGHTSMEN, Senior and Junior, for design of small or medium electro-mechanical apparatus. Men with good experience of pneumatically operated gear, machine tools or automobile work should be suitable. Good remuneration for reliable and experienced men.—Apply, quoting "Switchgear," to Staff Manager, General Electric Co., Ltd., Witton, Birmingham, 6. E9018 A

DRAUGHTSMEN required for work of high national importance, experienced in the design of light electro-mechanical apparatus.—Apply in writing (quoting ref. STK), Personnel Department, The General Electric Co., Ltd., Union Works, East Lane, Wembley, Middlesex. E8920 A

DRAUGHTSMEN, having first-class experience in the preparation of shop detail drawings for structural steelwork, are required by West's Gas Improvement Co., Ltd., Columbia House, Aldwych, London, W.C.2. E320 A

DRAUGHTSMEN, having first-class experience in the preparation of mechanical and structural shop detail drawings, are required by West's Gas Improvement Co., Ltd., Columbia House, Aldwych, London, W.C.2. E316 A

DRAUGHTSMEN.— Mechanical Engineering and Design Draughtsmen wanted for work on textile machinery. Textile knowledge not essential. Also Junior Draughtsmen. Good salaries paid.—Apply to the Personnel Manager, Platt Brothers and Co., Ltd., Hartford Works, Featherstall Road, Oldham. E383 A

DRAUGHTSWOMAN TRACER required for work on pencil and ink tracings, compiling of data sheets, charts, &c.; good conditions, five-day week.—Write, giving full details, to Chief Engineer, BOX 653, c/o Geo. Murray (Advertising), Ltd., 184, Strand, London, W.C.2. E9067 A

ELECTRICAL AND MECHANICAL Engineers and Metallurgists are required for experimental work at the Research Laboratories of the General Electric Co., Ltd., East Lane, North Wembley, Middlesex. Graduate staff are needed for work on radio communications, domestic heating appliances, illumination, light mechanical engineering problems and in the metallurgical field.—Applications, giving age and record, should be sent to the Staff Manager (Ref. GBLC/431). E9026 A

ELECTRICAL DRAUGHTSMAN required by the Bahrein Petroleum Co., Ltd., for their Bahrein installation, with minimum five years' experience lay-out and design of power stations, distribution systems, &c. Some experience in structural or mechanical work desirable. Age 25–40, with attractive salary on two years' agreements with paid local and home leaves. Free air-conditioned accommodation, board and medical attention, with provident fund benefits and kit allowance.—Apply in writing, with full particulars of age, experience salary required, &c., to BOX 3997, c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E417 A

ELECTRICAL ENGINEER, with three to five years' post-graduate experience, is required for the design of special types of small motors and generators to form part of a complete electro-mechanised system.—Applications, in writing, to be sent to the Staff Manager (Ref. GBLC/436), Research Laboratories of The General Electric Co., Ltd., East Lane, North Wembley, Middlesex, stating qualifications, age and experience. E9051 A

ENGINEER BUYER required by company manufacturing heavy engineering equipment. Salary £600 to £750 per annum. State age and give full details of experience and positions held.—BOX No. E9059, "The Engineer." A

ENGINEERING ASSISTANTS, with at least five years' experience in the design of structural steelwork and/or reinforced concrete structures, required by consulting engineers in Westminster. Apply, stating age, experience and salary required.—BOX No.E1455, "The Engineer." A

ENGINEERING ESTABLISHMENT, West London area, require several first-class Project Design Engineers for work of an intricate mechanical and electro-mechanical nature. Only qualified men, capable of undertaking complete design of projects, under guidance of chief engineer and chief design engineer, will be considered. Experience in either of the following fields will be advantageous:—Printing machinery, automatic feeding apparatus, teleprinter principles and electronic controls. Write in first instance, giving full experience and qualifications, to Chief Engineer.—BOX No. E8288, "The Engineer." A

ENGINEER, preferably under 40 and unmarried, to take charge of sales and service of high-pressure boiler mountings and valves in India for well-known company. A minimum of nine months' training in Great Britain would be given to successful applicant. Applicants, who should be European, should forward full details of qualifications and appointments held, together with age and salary required.—BOX No. E9003, "The Engineer." A

ENGINEERS required for work on quality control in building and civil engineering. Successful applicants will be employed initially at the company's central laboratory on research and testing concerned with concrete, and other materials and techniques used in building and civil engineering. They must, however, be prepared when trained, to travel to any part of Great Britain or abroad. The appointments offer an excellent opportunity of gaining a wide experience of building and civil engineering technique.—Write, stating age, experience, qualifications, and salary required, to G. Wimpey and Co., Ltd., Central Laboratory, Lancaster Road, Southall. E1488 A

ENGINEERS, with Degrees in Mechanical or Chemical Engineering, are required for the Bahrein Petroleum Company, Ltd., Persian Gulf, who have openings for (a) men not over 40 years of age, with three or more years' experience in oil refining, coal tar or chemical distillation plants; (b) graduates with experience to train in various phases of their process, design and development work. Living costs are low, the company providing free board, air-conditioned accommodation and medical attention. Kit allowance and provident fund.—Write, with full particulars of age, experience and education, to BOX 4035, c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E418 A

ENGINEER to take charge of Tendering Dept., accustomed handling commercial correspondence, home and export, preparation of composite tenders and specifications, fan experience desirable but not essential. Non-contributory superannuation.—Apply in writing to Aerex, Ltd., Fan Engineers, 46, Rutland Park, Sheffield. E1447 A

ESSO PETROLEUM Company, Ltd., have vacancies for Chemists and Chemical Engineers in the following supervisory posts at their new refinery at Fawley, near Southampton. Candidates should have a good Honours Degree and preference will be given to those with petroleum experience. These posts are pensionable. (A) Assistant Chief Chemist. Candidates should have a good Honours Degree, experience of supervising a laboratory with graduate and non-graduate staff engaged upon quality control and plant research work related to the manufacture of a wide range of petroleum products. (B) Process Engineer, to take charge of cracking section, technical service department. Candidates should preferably have experience of design and plant problems work on thermal and catalytic cracking units. (C) Process Engineer, to take charge of lubricating oils section, technical service department. Candidates should preferably have design and plant problem experience on lubricating oil processing plant.—Applications, stating age, qualifications, experience and salary required, should be sent to the Employee Relations Superintendent, Esso Petroleum Co., Ltd., Fawley, Southampton. E8924 A

ESTIMATOR/RATEFIXER required by a West Yorkshire firm of engineers. The person appointed will be required to take charge of a small staff collecting data for the costing department and progressing work through the factory. Duties will include estimating time and material, ratefixing, time and motion study. Salary £450/£500 p.a. Applications stating age and experience.—BOX No. E1472, "The Engineer." A

ESTIMATOR wanted, technician interested in analysis of production costs relative to methods of manufacture of light mechanical components.—Apply by letter, stating experience, qualifications and salary, to Chief Estimator, Teleflex Products, Ltd., High Road, Chadwell Heath, Essex. E1452 A

EXPERIENCED ESTIMATOR required for large iron and steel works in North Lincolnshire. Should be capable of preparing complete estimates for civil, structural and mechanical work for major extension projects from scheme drawings. Drawing-office experience essential and technical qualifications to Higher National Certificate desirable. Applicants should reply, stating age, salary required and full details of training and experience.—BOX No. E8796, "The Engineer." A

FITTER/TURNER required for small machine parts. Good working conditions.—Apply, Stability Radio Components, Ltd., Commerce Estate, Woodford Avenue, E.18. E1348 A

HANDLEY PAGE, LTD., have vacancies for Senior and Junior Technical Assistants in the Mechanical and Structural Test Departments at Radlett or Cricklewood. Qualifications should include a Degree or Higher National Certificate. Previous experience is desirable, but not essential. —Write, stating age, qualifications and details of experience, to Staff Officer, Handley Page, Ltd., Cricklewood, London, N.W.2. E8677 A

HAWKER AIRCRAFT, LTD., Kingston-on-Thames, require experienced Mechanical Draughtsmen, aged 25–35, for Lay-out Engineer office. Good conditions, interesting work; superannuation. Detailed applications to Personnel Officer. E8889 A

HYDRAULIC DESIGNER Draughtsmen required immediately by rapidly expanding company. Previous experience in this field essential. Also detail Draughtsman with light-mechanical detailing experience. Permanency for right man. —Apply only in writing, giving experience and salary required, to Chief Engineer, Exactor, Ltd., Church Way, Edgware. E8861 A

ILFORD LIMITED Engineering Research and Development Department have vacancies for Draughtsmen in the following categories:—(1) Electrical, drawing-office and workshop experience of power and lighting lay-outs is essential; (2) services, experience in practical schemes for boiler plant, refrigeration, and air conditioning is necessary; (3) mechanical design, a wide experience with mechanisms of all types is required. Permanent and well-paid positions in good working conditions will be offered to competent men.—Write fully to Ilford Limited, P.O. BOX No. 10, Romford, Essex. E1180 A

INSTRUMENT ENGINEER of Degree Standard required by chemical engineering contractors in Greater London area, for specification and purchasing of process control instruments and supervision of installation and servicing.—Applications to BOX No. E8775, "The Engineer" A

JIG AND TOOL Draughtsmen are required by a well-known engineering company in the North-West. Good canteen and first-class working conditions with excellent sports and social facilities. Five-day week. Assistance will be given to successful applicants to find living accommodation. Write, stating age, qualifications and experience, mentioning ref. ABE.—BOX No. E8933, "The Engineer." A

JIG AND TOOL Draughtsmen required. Previous aircraft experience not essential. Pension and life assurance scheme.—Apply, Employment Manager, Vickers-Armstrongs, Ltd. (Aircraft Section), Weybridge. E8915 A

JUNIOR DRAUGHTSMAN required for London office of chemical manufacturers. Previous D.O. experience not essential provided applicant has a good theoretical engineering training. State age, experience and salary required.—BOX No. E9024, "The Engineer." A

LEADING RAILWAY CARRIAGE Draughtsman required with general experience, especially of unit construction. Diesel railcar experience very desirable.—Apply BOX No. E8969, "The Engineer." A

LIBRARIAN required for technical department library in London office of major petroleum organisation. Graduate chemist or engineer preferred; age about 30 years. Applicants must be energetic and able to impart information to others. Pension fund benefits; good canteen facilities. Salary according to age, qualifications and experience.—Write, giving full details of education, qualifications, experience, &c., to BOX Z.Y. 945, Deacon's Advertising, 36, Leadenhall Street, E.C.3. E438 A

MECHANICAL DRAUGHTSMAN required for interesting work on a chemical and by-product plant near Wolverhampton. Applicants having experience in pipe work, storage tanks, pumps and engines and the lay-out of chemical plant will be given preference.—BOX No. E1416, "The Engineer." A

LEADING FIRM of civil engineering contractors carrying out extensive works at home and abroad, have an immediate vacancy for an exceptionally well-qualified and experienced Engineer to act as Contracts Manager on a group of civil engineering and building contracts variously situated in the British Isles. The person appointed to this position will be directly responsible to the board and, subject to satisfactory performance of his duties, will have an opportunity of joining the board in two to three years' time. Applications are invited, in confidence, only from qualified civil engineers or contract managers with at least ten years' experience in such a position and who have been earning a net salary of not less than £1750 per annum and can produce positive evidence to justify up to £2500 per annum basic salary. The position will involve full control of the contracts staff and personnel; supervision and approval of tenders; absolute control of costs; operation and organisation of the contracts sites. It is useless for anyone to apply who has not had senior experience in all of these particulars. Initiative and first-class ability as a negotiator absolutely essential. Age limits 35 to 50, liberal expense and car allowances, bonus and superannuation scheme.—BOX No. E9063, "The Engineer." A

MAJOR OIL COMPANY requires Mechanical Draughtsman for work at their London headquarters, with occasional visits overseas. Ordinary National Certificate essential, Higher National Certificate desirable. Applicants must have served a full apprenticeship, followed by two years' drawing-office experience with reputable engineering firm. A knowledge of plant installations, pipe lay-outs, pressure vessels design, structural steelwork and mass and reinforced concrete foundations, is desirable. Salary according to age, qualifications and experience.—Applicants should write, stating age, qualifications, &c., quoting Department M.1296, to BOX 5765, at 191, Gresham House, E.C.2. E182 A

MECHANICAL DRAUGHTSMAN required for engineers' dept. of a factory in Manchester area. Experienced in general engineering and plant lay-out, rubber works experience an advantage; age 23/30. Pension fund. Present staff aware of vacancy. Details of age, experience and qualifications and salary required.—BOX No. E1475, "The Engineer." A

MECHANICAL, STRUCTURAL or General Engineering Draughtsmen wanted for aircraft work. Previous aircraft experience not essential. Pension and life assurance scheme. — Apply, Employment Manager, Vickers-Armstrongs, Ltd. (Aircraft Section), Weybridge. E8494 A

MECHANICAL ENGINEER required for the progressing and inspection of equipment being purchased in the United Kingdom for Mines abroad. General knowledge of mining plant, power plants and mechanical handling plant an advantage but men conversant with general heavy engineering machinery would be suitable. The person appointed would be based in London but would be required to visit manufacturers' works in the U.K. for the purpose of reporting manufacturing position of equipment on order, and to determine the quality and accuracy of workmanship prior to acceptance of the equipment for shipment abroad. Applicants should submit details of training and experience and state salary required.—Apply to BOX No. 5311, Walter Skinner, Ltd., 20, Copthall Avenue, London, E.C.2. E8964 A

MECHANICAL ENGINEERS required by large oil company for service overseas. Candidates must have (a) five years' apprenticeship and possess the Higher National Certificate in Mechanical Engineering, or (b) two years' practical experience with the following: (i) an Engineering Degree and/or (ii) be Graduates or Associate Members of the Institution of Mechanical Engineers. Candidates under category (a) age limit 23–28, under category (b) between ages 23–30; married men under 26 years of age will not be considered for either category. Initial contracts three to four years; commencing salary £620 p.a. upwards, according to age and qualifications; pension scheme benefits and local cost-of-living allowances; £85 outfit allowance; first-class passages provided. Excellent prospects of progressive career.—Apply in writing, giving age, with full particulars of education, qualifications and experience, to BOX Z.V.894, Deacon's Advertising, 36, Leadenhall Street, E.C.3. E435 A

METHODS ENGINEERS required to investigate shop problems and to initiate new methods and processes in connection with manufacture of high voltage switchgear. Applicants must have a wide practical experience and possess technical qualifications of H.N.C. standard or its equivalent. Very good prospects.—Write, stating full details of previous experience, &c., and salary required, quoting Ref. IJC, to BOX No. E8991, "The Engineer." A

METHODS ENGINEERS required to investigate works lay-out and to carry through reorganisation and works lay-out projects in connection with the manufacture of high voltage switchgear. Applicants must have a wide practical background with administrative experience, knowledge of modern methods and possess technical qualifications to H.N.C. standard.—Write, stating full details of experience, &c., and salary required, quoting Ref. IJD, to BOX No. E8992, "The Engineer." A

MECHANICAL ENGINEER, Internal Degree (or equivalent), workshop training, experienced in applied physics.—Candidates should apply in writing, giving full details, to Consultant Engineer, Ilford, Limited, Romford, Essex. E8909 A

MONSANTO CHEMICALS, Limited, require Draughtsmen with electrical knowledge for the Engineering Department in London. Applicants should have served an apprenticeship, reached National Certificate standard, and have at least two years' experience in power and lighting requirements for chemical plants; knowledge of flameproof installations is desirable. One vacancy requires specialised knowledge of electrical detail of industrial instruments as used in process control systems in chemical plants. Experience of electrical circuits for control instruments, remote control by means of relay or electronic equipment and automatic safety systems is desirable. The positions are permanent and pensionable, and the salaries are in the bracket £550–£750 per annum, according to qualifications and experience.—Apply in writing, giving full details of age, education, training and experience, to Chief Personnel Officer, Monsanto Chemicals, Limited, 8, Waterloo Place, London, S.W.1. E9052 A

MONSANTO CHEMICALS, Limited, req... Design Engineers for the Engineering Depart... in London. Applicants should preferably ... Associates of the Institution of Mechanical ... neers or hold at least Higher National Certi... with three years' or more experience in the d... and lay-out of chemical plant. The posts are ... manent and pensionable, and the salaries in ... bracket £700–£1000 per annum, according to ... fications and experience.—Apply in writing, ... full details of age, education, training and exp... ence, to the Chief Personnel Officer, Mons... Chemicals, Limited, 8, Waterloo Place, Lond... S.W.1. E90...

PETERBROTHERHOOD,LTD., Peterbo... require Draughtsmen (senior and junior), pr... ably with experience in design of compres... turbines and steam engines. Permanent posi... five-day week, staff pension scheme. Write, gi... full details age, experience and salary required. E9...

PHYSICISTS AND ENGINEERS for Ins... ment Work. Imperial Chemical Industries ... vacancies in their Billingham Division for Physi... and Engineers, to carry out research and deve... ment on measuring, recording and autom... control instruments, and to supervise work ... of them; also for experimental stress anal... Candidates should be between 22 and 45 years ... age. They must have an Honours Degree ... preferably some practical or research experience. Please write, giving full details of qualifica... and experience, &c., quoting Ref. A.5, to ... Staff Manager, Imperial Chemical Indust... Limited, Billingham Division, Billingham, ... Durham. E90...

PLANNING ENGINEER required, to specia... in schemes for the promotion of aircraft gas turb... component interchangeability for the simplifica... of overhaul in quantity. Experience of compon... manufacture and assembly is essential. Ap... giving age, experience and salary required.—B... No. E9056, "The Engineer."

PLANNING ENGINEER required with ... least five years' experience of planning methods ... light electrical products involving mass produc... tooling and lay-outs; H.N.C. or equiva... essential.—Write, giving age, details of experie... and salary required, to Personnel Manag... Standard Telephones and Cables, Ltd., Warw... Road, Boreham Wood. E9046

PLANT DEVELOPMENT and Process En... neers, qualified in chemical engineering or petrol... refining technology, required by Bahrein Petrole... Company, Limited. Age limit 25–40. Two-y... agreement periods with passages and paid leav... Free air-conditioned accommodation, board, ... medical attention, kit allowance, low living co... Salary according to experience.—Write, with f... particulars of age, education, experience, to BO... 3764, c/o Charles Barker and Sons, Ltd., 31, Bud... Row, London, E.C.4. E41...

POWER ENGINEERS are required for serv... with the Bahrein Petroleum Co., Ltd. The qu... fications required are a Degree in Electrical En... neering, followed by several years' experience ... electrical power and steam distribution in ... modern power plant. Age limits 25–40 ye... with salaries according to qualifications a... experience. Board, air-conditioned accommod... tion and medical attention are provided in ad... tion to salary. A kit allowance is given for ini... tour and employees participate in a pension scheme. Agreement periods are twenty-four to thirty mont... with paid local and home leaves.—Write with f... particulars of qualifications, experience and sala... expected, to BOX No. 4984, c/o. Charles Bark... and Sons, Ltd., 31, Budge Row, London, E.C.4. E434

PRIVATE MANUFACTURING COMPANY (not engineering), small, but enterprising, h... vacancy for well-educated, hardworking Mi... determined to make progress. Applicants must b... familiar with general commercial practice and ha... proved themselves capable of administration an... staff control in a commercial organisation. The... should be of a practical nature, with an alert mind, ... but also deepthinking and able to analyse a situa... tion clearly. Ample scope exists for applicant ... giving full satisfaction. Apply in own handwriting, ... stating age, experience and approximate salary.—... BOX No. E1490, "The Engineer." A

PROCESS PLANNING ENGINEER require... by engineering organisation of national repute ... situated in Outer Eastern London area. Appli... cants should be under 36 years of age, have wid... knowledge and experience of mass production of ... forgings, and be fully competent to prepare ... specifications for all modern plant and equipment, ... and to plan in detail the complete processing of a ... wide variety of forgings. An attractive position ... offering considerable scope for advancement to a ... man who can accept responsibility. This is an ... established post with entitlement to participate in ... the company's non-contributory pensions scheme. ... Salary paid will be commensurate with qualifica... tions and experience; five-day working week.—... Replies should be addressed to BOX No. E901... "The Engineer," stating age and giving full details ... of education, experience and qualifications. Refer... ence "K/PPE" should be quoted. A

PRODUCTION CONTROLLER required by ... engineering company situated in the London area. ... Applicants should have experience of materials ... control and progress as applied to large quantity ... production in the engineering industry. Appli... cants must have initiative and drive with ... determination to overcome difficulties. The posi... tion is permanent and the company operates a ... pension fund. State full particulars of experience ... with age and salary required.—BOX No. E9046, ... "The Engineer." A

PROGRESS SUPERVISOR required in the ... machine shop of large light engineering com... pany situated in the eastern suburbs of London. ... Applicants must have experience in progress and ... production control and should be competent to ... undertake the control of progress in a machine ... shop using batch production methods. The position ... is permanent and offers excellent opportunities. ... Please state full details.—BOX No. E9048, "The ... Engineer." A

REINFORCED CONCRETE DETAILER ... required by London firm of contractors. Candi... dates should be capable of building up working ... drawings from an outline design, and of doing ... elementary design.—BOX No. E1489, "The ... Engineer." A

SITUATIONS VACANT

UALIFIED and Experienced Mechanical, and Chemical Engineers, for senior posts with ellent prospects, are required to work in the ster London area, by leading firm of mechani- engineering contractors and plant manufac- . Minimum qualifications are Associate bership of Institution of Mechanical, Civil Chemical Engineers, plus engineering degree equivalent diploma. Salary commensurate experience.—Applications, with fullest details, fidence, to BOX No. E8640, "The Engineer." A

UALIFIED ENGINEER required to fill the ition of Production Controller. Duties would o-ordinate the work of planning, progress and erial control departments in a large West Riding neering firm. Applicants should have sound wledge of modern production methods as lied to medium engineering. Write, giving age, particulars of qualifications, previous experi- and salary required.—BOX No. E1425, "The ineer." A

TE FIXER required, light electrical engineer- Must be fully experienced.—Write (quoting STK), Personnel Department, The General tric Co., Ltd., East Lane, Wembley, Middlesex. E8921 A

QUIRED for Aircraft Engineering Develop- Laboratory.—The Bristol Aeroplane Com- Limited, have vacancies for Test Assistants general duties in connection with structural mechanical testing, design of test rigs, test lysis, &c. Higher National Certificate and erience in this class of work desirable.—Applica- to the Personnel Manager (Aircraft Division), on House, Bristol. E8911 A

NIOR AND JUNIOR Civil Engineers uired overseas for harbour, dock and power ion construction. Salary according to experi- . Apply, stating age and experience.—BOX E1450, "The Engineer." A

NIOR DESIGN DRAUGHTSMAN ently required. Fully experienced in engine detail design, good mechanical man will be sidered. Salary according to experience, but less than minimum A.E.S.D. rate for age.—. ply, Russell, Newbery and Co., Ltd., Essex rks, Rainham Road South, Dagenham, Essex. E9064 A

NIOR DIE DESIGNERS required by all- d automobile body manufacturers, West London trict, experienced in design of single and double- ion, light and heavy dies for auto. body press- ; also Senior Jig Designer, experienced in sign of detail and assembly jigs for all-steel auto. y manufacture; five-day, 40-hour week, good sion, library and social club facilities.—Write, ting details of age, experience and salary uired, to BOX E 108, L.P.E., 110, St. Martin's ne, W.C.2. E9035 A

NIOR DRAUGHTSMAN required, conver- t with crane and hoisting machinery.—Apply, ting qualifications, experience and salary re- ired, to Woodfield Hoist and Associated Indus- es, Ltd., Frindsbury Works, Rochester, Kent. E1444 A

NIOR DRAUGHTSMAN required for velopment work special purpose machines, light d medium heavy. Applicant must be capable of mplete design from engineers' data and sketches. owledge of glass an advantage. Minimum salary E.S.D. Excellent opportunity for right man.— OX No. E436, "The Engineer." A

NIOR DRAUGHTSMEN urgently required r rapidly expanding company in North London es. Experience in oil hydraulic equipment ential. Good conditions and salary; per- anency for right men.—Write, giving full par- culars, to Chief Engineer, BOX 651, c/o Geo. urray (Advertising), Ltd., 184, Strand, London, .C.2. E9065 A

NIOR DRAUGHTSMEN required in Man- hester, 25 years of age and upwards, experienced the design and detail of mechanical handling ant and structural steelwork. General engineer- g training to H.N.C. standard preferred. Good lary. Production bonus in operation.—Apply to E" Department, West's Gas Improvement Co., d., Albion Ironworks, Miles Platting, Man- hester, 10. E138 A

NIOR DRAUGHTSMEN, experienced in he design and detail of chemical engineering plant, tructural steelwork, pipework or pressure vessels, re required by engineering company in Manchester ea; sports and social activities, excellent canteen d welfare service; pension scheme in operation. pply, quoting Reference A/7, and giving full tails of experience, qualifications and salary quired.—BOX No. E9045, "The Engineer." A

NIOR ESTIMATOR required by all-steel utomobile body manufacturers, West London trict, to compile production estimates and cost rochures for auto. body detail, assembly manu- cture and treatments; to control cost achieve- ent records, and advise on methods of efficiency. timator, with similar experience to above, also quired; five-day, 40-hour week, good canteen d social club facilities.—Write, stating tails of age, experience and salary required, to OX E 109, L.P.E., 110, St. Martin's Lane, W.C.2. E9036 A

NIOR JIG AND TOOL Designers required, -Write, giving full details of previous experience, the Personnel Officer, The de Havilland Engine o., Ltd., Stag Lane, Edgware, Middlesex. E312 A

NIOR TECHNICIANS with Honours egrees, having served an apprenticeship with bsequent experience both in the operation of achinery and in machinery design; age over 30 ars. These positions offer good opportunities r experienced men; Ref., Tech. 2. Junior echnicians with Honours Degree, preferably with o years' practical apprenticeship; Ref., Tech. 3. unior Technician with University Degree, for pecialisation in instrumentation. Applicants for is position should have some experience in elec- onics; Ref., Tech. 4. Senior and Junior Test ngineers with University Degree; previous expe- ence on test rig work in engineering an advantage; ef., Tech. 5. Draughtsmen with good general xperience in mechanical engineering, preferably ircraft. Good salaries paid to suitable men; ef., D.O.6.—Applications, giving full particulars qualifications and experience, quoting reference umber, should be forwarded to Senior Personnel fficer, Vickers-Armstrongs, Ltd., Barrow-in urness. E8791 A

SEVERAL VACANCIES exist in the development laboratory of the General Electric Co., Ltd., Witton, for Development Engineers in the electronics, small motor, engineering and protective gear sections. Applicants should preferably possess a Degree or Higher National Certificate in Electrical Engineering, but those taking their final examination this year will also be considered. Salaries will depend upon qualifications, age and experience.—Apply in writing, giving full particulars and quoting "Development Laboratory," to Staff Manager, General Electric Co., Ltd., Witton, Birmingham, 6. E3930 A

SIMON-CARVES, LIMITED, require Senior Draughtsmen, experienced in the design and detail of chemical handling plant, structural steelwork, pipework or pressure vessels. Pension scheme in operation.—Applications, giving details of age, experience and training, and quoting PE/703, to Personnel Manager, Simon-Carves, Ltd., Cheadle Heath, Stockport. E3830 A

SITE ELECTRICAL ENGINEER, experienced heavy plant installation work, building lighting, &c., for supervision of contractors, &c. Apply, stating age, experience, &c., salary required.—BOX No. E431, "The Engineer." A

SITE ENGINEER, experienced plant installation, supervision of plant foundations, buildings, services, &c., for expansion scheme. Apply, giving age, experience, salary required, &c.—BOX No. E430, "The Engineer." A

SPERRY GYROSCOPE CO., LTD., Great West Road, Brentford, Middlesex, require Senior Draughtsmen, (a) electronics, and (b) with precision electro-mechanical experience; Junior Draughtsmen, for detail and assembly work.—Write, with full details, age and salary required, to the Personnel Manager. E399 A

SPERRY GYROSCOPE CO., LTD., Great West Road, Brentford, Middlesex, require Electronic Engineer. Good academic qualifications and recognised apprenticeship desirable. Required for development work on control systems. Experience of D.C. amplifiers and computing devices an advantage.—Apply, with full details of experience and salary required, to the Personnel Manager. E361 A

SPERRY GYROSCOPE CO., LTD., Great West Road, Brentford, Middlesex, require Mechanical Engineer. Good academic qualifications and recognised apprenticeship desirable. Preferably experienced in one or more of the following:—Precision mechanical design, hydraulics or pneumatic servo systems, servo theory, aerodynamics.—Apply, with full details of experience and salary required, to the Personnel Manager. E363 A

SPERRY GYROSCOPE CO., LTD., Great West Road, Brentford, Middlesex, require Electro-Mechanical Engineer. Good academic qualifications and recognised apprenticeship desirable. Experience in electrical and electro-mechanical methods of computation, servo theory and instrument design preferred.—Apply, with full details of experience and salary required, to the Personnel Manager. E359 A

STRUCTURAL DESIGNERS and Designer Draughtsmen, with experience in light steel structures, required for work in London office in connection with radio masts and towers.—Apply, stating age, qualifications, experience and salary required, to the Staff Officer, British Insulated Callender's Construction Company, Limited, 21, Bloomsbury Street, London, W.C.1. E349 A

STRUCTURAL ENGINEERS, London area, require Outside Erection Manager. Full details of experience, age and salary required.—BOX No. E1457, "The Engineer." A

STRUCTURAL ENGINEERS, West London district, require Draughtsman, fully experienced designing and detailing light to medium structures; canteen; pension scheme; house if required. Age, experience and salary.—BOX No. E1458, "The Engineer." A

STRUCTURAL STEELWORK detail Draughtsmen required in Manchester. Good salary; production bonus in operation — Apply to "E" Department, West's Gas Improvement Co., Ltd., Albion Ironworks, Miles Platting, Manchester, 10. E147 A

TECHNICAL ASSISTANT required with experience in designing and estimating gasworks, by-product and chemical plant. Applicants should be about 30 years of age, preferably in possession of a degree in Gas or Chemical Engineering or an equivalent qualification. Good prospects for the right type of applicant with participation in bonus scheme and superannuation.—Please write, stating age, training, experience and salary required, to the Personnel Officer, Newton Chambers and Co., Ltd., Thorncliffe, near Sheffield. E3778 A

TECHNICAL MANAGER required by company manufacturing water-tube boilers. State age, qualifications, experience, &c. Salary offered £1800–£2000 per annum.—Applications should be addressed to BOX No. E3987, "The Engineer." A

THE ADVERTISING DEPARTMENT of a large engineering organisation in the North-West has a vacancy for a young Copywriter for duties connected with technical catalogues, leaflets, and advertisements; essential qualifications are engineering knowledge and writing experience; some knowledge of advertising practice would be an advantage; a pension scheme is in operation; holidays are generous and working conditions and prospects are good; salary according to experience, but not less than £400 per annum. Full details.—BOX No. E1409, "The Engineer." A

THE ANDERSTON FOUNDRY Co., Ltd., railway permanent way engineers and ironfounders, require the services of an Assistant Works Manager. Applicants should have sound training in mechanical engineering, with practical foundry experience. Administrative experience an advantage. Good prospects for the right man.—Apply, stating age, experience and salary required, to the Secretary at Port Clarence, Middlesbrough. E9060 A

THE PERUVIAN CORPORATION, Ltd., Assistant to Chief of Traction, Peruvian Railways, age 26/35, qualifications: apprenticeship with steam locomotive builders or main line railway workshops, main experience with a locomotive running department. Knowledge of diesel power an asset. Higher National Certificate for Mechanical Engineering or Graduate of Institution of Mechanical Engineers. A knowledge of Spanish an advantage.—Apply to the Secretary of the Peruvian Corporation, Limited, 144, Leadenhall Street, London, E.C.3. E424 A

THE DE HAVILLAND ENGINE CO., Ltd., have vacancies in their design office at Stag Lane for Senior Design Draughtsmen for work on gas turbine development and other projects. Good salaries and prospects for suitable applicants. Superannuation scheme.—Apply, giving details of previous experience and salary required, to the Personnel Officer, Stag Lane, Edgware, Middlesex. E407 A

THE NATIONAL BOILER and General Insurance Co., Ltd., St. Mary's Parsonage, Manchester, 3, has vacancies for Lift and Crane Inspecting Engineers in London and the Midlands. The position is a permanent one with progressive salary commencing at £520 and rising to £750 per annum, with non-contributory pension. Candidates should be about 30 years of age, having served an apprenticeship and having sound practical engineering knowledge. Candidates should hold the Higher National Certificate in Mechanical or Electrical Engineering. Applicants with First Class M.O.T. Certificate would be considered.—Apply in own handwriting and mark the envelope "Lift and Crane Inspecting Engineer," giving age, training and experience, also copies of testimonials. E9049 A

THREE SENIOR MECHANICAL and One Electrical Crane Draughtsmen required. Excellent opportunities and prospects.—Apply in strict confidence to Joseph Adamson and Co., Ltd., Hyde, near Manchester. E3937 A

TIME STUDY ENGINEER who has served machine shop and engineering apprenticeship and had time study training under good instructors. Some knowledge of synthetics desirable. A permanent, pensionable position in established work study department of a large firm, South London. Salary £8 to £10, according to age and experience.—Write BOX No. E8877, "The Engineer." A

TRACERS (FEMALE), with experience of making ink tracings of engineers' drawings, required by A.E.C., Limited, Southall, Middlesex. Applications in writing to Staff Records Office, stating age, experience and salary required. E8755 A

TURBINE DESIGN DRAUGHTSMEN required, must be experienced job-leaders. Good salary for right men.—Apply, stating full particulars of training, qualifications, experience and salary required, to Personnel Manager, Fraser and Chalmers Engineering Works, Erith, Kent. E1503 A

TWO MECHANICAL DESIGN draughtsmen required, also a number of Detail Draughtsmen on very interesting work in our Bath offices. Good wages, lodgings available for single men.—BOX No. E8875, "The Engineer." A

VACANCIES for Mechanical Draughtsmen exist with the research and development group of a major industrial company in the West End of London. Experience of chemical plants desirable, but not essential. Initial salary according to experience and qualifications.—Reply, giving full details of age and experience, to Dept. M 83, The British Oxygen Co., Ltd., Bridgewater House, Cleveland Row, St. James's, London, S.W.1. E9000 A

VACANCIES for Three Senior Draughtsmen exist with the British Oxygen Company, Limited, for work in the West End of London. Experience of plant lay-out or design or compressors/pumps an advantage. Duties also include site visits.—Reply, giving full details and salary required, to Dept. M.100, the British Oxygen Co., Ltd., Bridgewater House, Cleveland Row, St. James's, London, S.W.1. E8998 A

WANTED, first-class Machinery Buyer, for old-established machinery house in Birmingham. Must be thoroughly experienced in all classes of machine tools and sheet metal working machinery. Especially good prospects for man with marked ability. State full personal details and experience and starting salary required.—BOX No. E1505, "The Engineer." A

WANTED, FOR ENGINEERING WORKS in Western District of Glasgow, enterprising young Man with first-hand knowledge of work on modern machines, particularly combinations in lathes and boring and facing machines. It is preferred that applicant has knowledge and would carry out ratefixing duties. When replying state previous experience and salary expected. The appointment is covered by a superannuation scheme. It provides scope for organising ability and opportunity for rapid promotion.—Address, 2166, Wm. Porteous and Co., Glasgow. E9013 A

WELL-KNOWN engineering firm engaged on the construction of high pressure water tube boilers and auxiliary plant requires the services of an Operating Engineer to commission and service new plants in various parts of the country. Candidates must have had experience of this type of work and must be in possession of suitable engineering qualifications. Salary in accordance with age, qualifications and experience. An expenses allowance will be granted.—Applications, quoting Reference A/9, with full details of experience and qualifications, to BOX No. E8865, "The Engineer." A

WELL-KNOWN FIRM of heavy industrial plant engineers has vacancies at its London office for Reinforced Concrete Designing Engineers with experience in all types of industrial structures. Senior and Junior Draughtsmen are also required. Pension scheme in operation. Apply briefly, quoting Reference A/10, stating previous employers, with dates and positions held.—BOX No. E8906, "The Engineer." A

WELL-KNOWN manufacturers of precision aircraft instruments, situated in the West of England, have a vacancy in their expanding laboratories for a Senior Mechanical Engineer to control design and development of a wide range of aircraft instruments and allied equipment. Applicants should have a sound technical education, with previous design experience in pressure sensitive elements and intricate mechanisms. Salary scale, £750–£1000, depending upon age and experience. Assistance in housing accommodation to selected candidate.—Apply, giving details of qualifications and experience, to BOX No. E8959, "The Engineer." A

WELL-KNOWN MIDLAND FIRM of light precision engineers have a vacancy for a first-class Gauge Designer. Applicants must be conversant with line and mass production methods by semi-skilled labour. Only consideration will be given to first-class men. Please state in chronological order age, experience and salary required.—BOX No. E1462, "The Engineer." A

WORKS ENGINEER OFFICE Assistant required to build up new branch of plant lay-out section in large works, South London. Duties will include responsibility for plant record and history cards, preparation of time tables for plant overhaul, progressing of plant movement forms and generally dealing in the records and forms used for planning and control of maintenance costs. Planning mentality essential and both technical and office experience desirable.—State age, salary required and full particulars to BOX No. E8972, "The Engineer." A

WORKS MANAGER.—Applications are invited for position of Works Manager for mechanical engineering works employing approximately 250 in N.E. London area. Machining and assembly of medium and heavy machines. No foundry or press work. Write, in first instance, giving full details of previous experience, which should, if possible, include experience in mechanical drawing-office, and state approx. salary required.—BOX No. E1434, "The Engineer." A

WORKS MANAGER required by an old-established engineering firm in the South-West. Experience in the complete manufacture of steam locomotives essential and diesel desirable. Contributory pension scheme. Applications to state experience, age and salary required.—BOX No. E1408, "The Engineer." A

WORKS MANAGER, with previous successful administrative and technical experience for very high-grade engineering products. Internal combustion engines and vehicles, also aircraft components. Expanding company of high reputation employing nearly 400. Very modern plant, including many multi-spindle lathes and drills. Please write, giving full details of experience and salary required.—BOX No. E1465, "The Engineer." A

YORKSHIRE TAR DISTILLERS, Ltd., require experienced Draughtsman/Engineer at their Head Office, Engineering Dept., Cleckheaton. Applicants should give details of their age, qualifications, experience and salary required. Applicants should have mechanical engineering background and experience of chemical plant. There is a contributory pension scheme available.—Please reply to the Secretary, Y.T.D., Ltd., Cleckheaton. E9034 A

SITUATIONS WANTED

A.M.I.MECH.E. (27), mechanical, structural general engineering, cranes, &c., design, works, erection, installation, commercial experience, seeks move to larger firm. At present Asst. Chief Engineer with salary £750.—BOX No. E1483, "The Engineer." B

AS COMMERCIAL MANAGER, with view to General Management, sought by B.A. (Mech. Sc.), B.Com.; age, a young, healthy, energetic 48 years. Sound organising, executive and administrative experience in production, service, commercial management, business development. Wide knowledge of light mechanical engineering and electrical industries. Excellent high-level contacts in industry and Government departments. Minimum salary £1750 p.a.; London or overseas preferred, but completely mobile. Alternative appointment, offering similar scope, considered.—Byng-Douglas, 41, Kelso Place, W.8. E1387 B

CHIEF BUYER seeks change. Excellent contacts all markets; fully conversant modern control systems. Keen administrator.—BOX No. E1436, "The Engineer." B

CHIEF INSPECTOR, qualified engineer, present employed Provinces, seeks post London area for domestic reasons. Experienced general mechanical parts equipment radio, electronics, A.I.D., I.N.O., C.I.A., A.R.B., staff around 250.—BOX No. E1476, "The Engineer." B

CHIEF INSPECTOR desires similar appointment. Extensive experience, high precision products. Mechanical engineering, excellent record organisation, administration.—BOX No. E1478, "The Engineer." B

CONTINENTAL Technical Representative or Resident Engineer. Englishman, aged 40, single, fluent French and German. Experienced technical correspondent, factory planning, costing and estimating, installation of heavy mechanical and hydraulic plant, heating, ventilating and mechanical handling. Contract recently completed, seeks fresh post abroad. Salary grade £800 plus living allowances, according to conditions.—BOX No. E1369, "The Engineer." B

DREDGING FOREMAN (40), wide experience contracts, home and abroad. Bucket, cutter-suction spud dredgers, transporters, all types, and reclamation work. Good working knowledge French, Dutch.—BOX No. E1480, "The Engineer." B

ENGINEER PHYSICIST (41), high qualifications, wide experience research design development, technical management, consulting, specialised knowledge gas and fuel-utilisation, light engineering, desires progressive change view Management.—BOX No. E1481, "The Engineer." B

ENGINEER (42), B.Sc. (Eng.), with experience in well-known medium and large light electrical engineering companies, including ten years as works manager, seeks new post offering scope for advancement.—BOX No. E1410, "The Engineer." B

EXECUTIVE ENGINEER, 45 yrs., seeks position as Production or Works Manager. Sound knowledge of batch and line production, this country and abroad.—BOX No. E1479, "The Engineer." B

FOUNDER DIRECTOR of a very successful engineering firm desires a change; experienced engineer, workshops, drawing-office, estimating and design, considerable outside erection and site work experience, and a very wide knowledge of office administration. Will consider any reasonable offer. Willing to travel.—BOX No. E1374, "The Engineer." B

GAS TURBINES.—Chief Production Engineer desires change. Ten years' practical and administrative experience producing combustion equipment. Press, machine and assembly, keenly interested in mass production.—BOX No. E1482, "The Engineer." B

For continuation of Small Advts., page 8

SITUATIONS WANTED

INSPECTING AND TESTING Engineer, operating all over Midlands, invites additional work.—BOX No. E1060, "The Engineer." B

MATERIALS and Contracts Progress.—Adviser, a well-known figure in engineering and steel, desires engagement. Practical and technical engineer, with important connections at all levels over Great Britain. Replies in confidence.—Write, BOX 8207, c/o White's, Ltd., 72, Fleet Street, E.C.4. E8854 B

MECHANICAL/ELECTRICAL Engineer (27), Internal Degree, B.T.H. apprenticeship, three years' foreign erection/commercial experience, desires post, home or abroad, preferably on sales side. Languages.—BOX No. E1271, "The Engineer." B

MECH. ENGINEER (27), passed A.M.I.Mech.E. exam., G.I.Prod.E., resident London, 12 years' design, works, tech. sales, admin. experience, seeks post where ability to develop new products and organise sales is required. Min. salary £750 p.a.—BOX No. E1371, "The Engineer." B

POSITION as Technical Sales Trainee desired by young man, age 25, smart appearance, Engineering Degree Course completed; willing to travel. Speaks French and Spanish.—BOX No. E1497, "The Engineer." B

PRACTICAL WORKING ENGINEER and Erector, 30 years, very wide experience all kinds mechanical, electrical, erections, plant, installations, seeks position as Supervisor, Foreman or help Outdoor Service Dept.; willing to devote whole time to any new work, project, &c. Free to travel. Helpful, trustworthy, conscientious worker.—BOX No. E1495, "The Engineer." B

SALES OR GENERAL MANAGER.—Engineer, with wide technical and managerial experience, home and abroad (I.C. engines, m/c tools), contemplates change later in year. Outstandingly successful record. First-class connections throughout world. Widely travelled, several languages fluent. Interested only in highly responsible post offering fullest scope.—BOX No. E1500, "The Engineer." B

SOUTH COAST D.O. post required by senior engineer, A.M.I.A.E., jigs, fixtures, I.C.E., sheet metalwork and special-purpose machines.—BOX No. E1438, "The Engineer." B

TECHNICAL SALES REPRESENTATIVE (Midlands), 25 years' experience design, production and sales, air compressors, centrifugal pumps, &c., desires Additional Agencies on commission basis for equipment allied to above products.—BOX No. E1498, "The Engineer." B

TUG MASTER, just home from Africa, used to all types of marine work, requires new contract, preferably foreign.—BOX No. E1453, "The Engineer." B

YOUNG ENGINEER, Public School education, general engineering apprenticeship, O.N.C., 2nds M.O.T. Cert., requires situation with firm in London area offering permanency and opportunity for advancement.—BOX No. E1484, "The Engineer." B

YOUNG ENGINEER (27), time served toolroom, good board and works experience, H.N.C. (Mech.), First-Class C. and G. Cert. (Machine Shop Eng.), would like opportunity to assist works manager or works engineer in Manchester or North Manchester area.—BOX No. E1437, "The Engineer." B

AGENCIES

TWO MEN, with excellent connections in engineering, industry, public bodies, &c. (Scotland), seek Agency for engineer supplies, plant or speciality equipment. — Address, 2560, Wm. Porteous and Co., Glasgow. E9071 D

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MULTI-SPINDLE and Single-Spindle Automatic Capacity required, ¾in. to 2in. capacity.—Apply, Sub-Contracts Dept., C.A.V., Limited, Acton, London, W.3. E332 MW

PATENTS

THE PROPRIETOR of British Patent No. 600,260, which relates to "Apparatus for and a Method of Working Sheet Metal," is desirous of entering into arrangement by way of Licence or otherwise on reasonable terms for the purpose of exploiting the invention covered by this patent and ensuring its full development and practical working in Great Britain.—All communications should be addressed in the first instance to Leslie N. Cox, 329, High Holborn, London, W.C.1. E1467 H

THE PROPRIETORS of British Patent No. 506,249, for "Arrangement of Bearing for Separators and Other Machines Fitted with a Vertical Quickly Rotating Spindle." desire to enter into negotiations with a firm or firms for the Sale of the Patent or for the grant of Licences thereunder.—Further particulars may be obtained from Marks and Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E9054 H

THE PROPRIETORS of Patent No. 588,091, for "Irreversible Transmission," desire to secure commercial exploitation by Licence or otherwise in the United Kingdom.—Replies to Haseltine Lake and Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. E8960 H

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14 gauge Galvanised Wire.
BOX No. E9030, "The Engineer." I

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CHAMBERLAIN and WILLOWS, 23, MOORGATE, E.C.2 (CITy 6013). E8753 L

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BOX No. E8919, "The Engineer." K

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E143 F

B.M.S. BARS required, ¾in. and 1in. dia., Flats 3in. by ½in., 2½in. by ¼in. and ¾in. by ¼in.—Gorta Engineering, Chester Road, Boreham Wood, Herts (Elstree 3146). E1443 F

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WANTED, Garrett 160/190 B.H.P. Locomobile, with coal or oil-firing equipment or suitable for wood firing.
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WANTED, 10,000ft. run 7in.–12in. Casing Pipes, swelled and recessed joints.
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WANTED, good used Planing Machine, min. planing length 14ft. by approx. 3ft. 6in. to 4ft., with two boxes on the cross rail, preferably motorised for three-phase supply.
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For continuation of Small Advts., page 1

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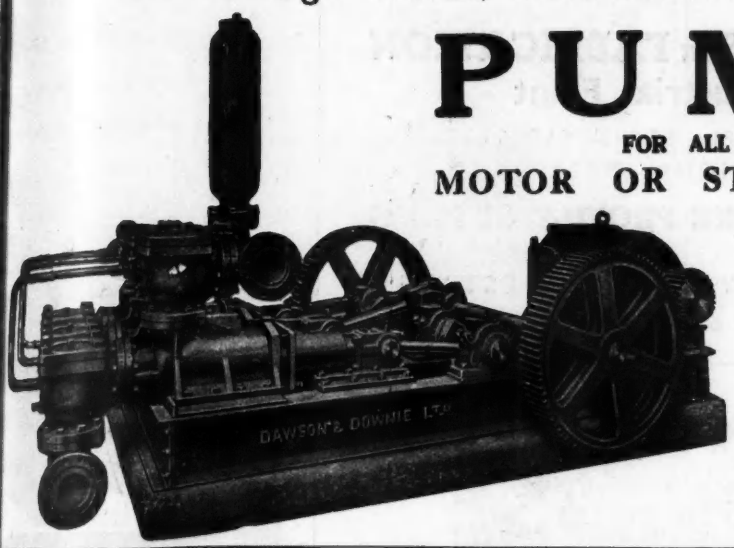

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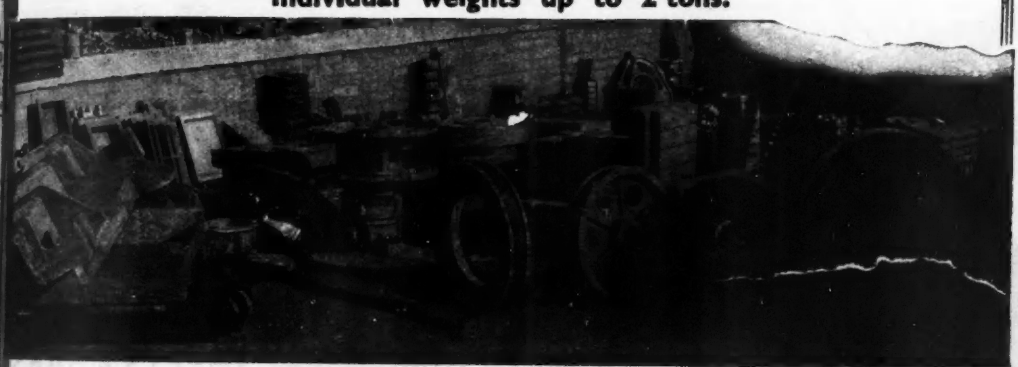

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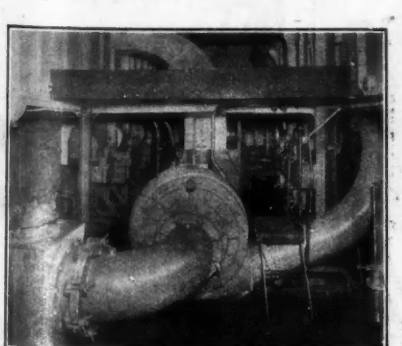

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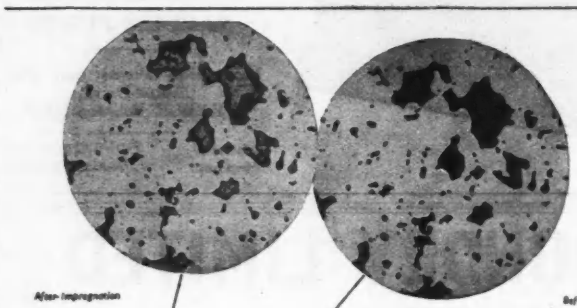

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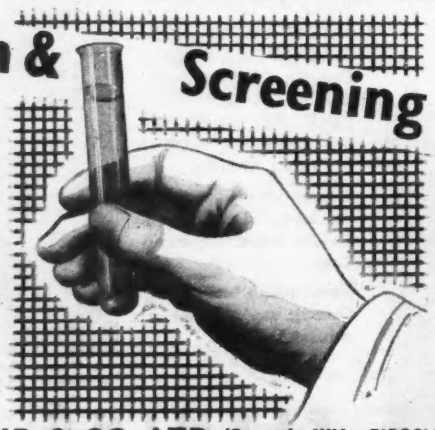

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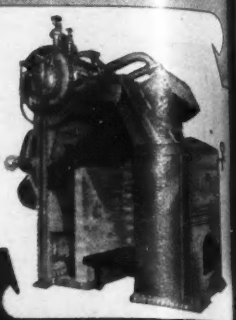

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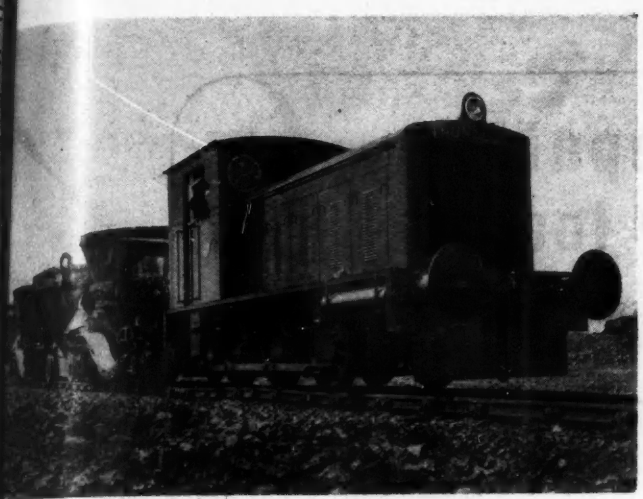

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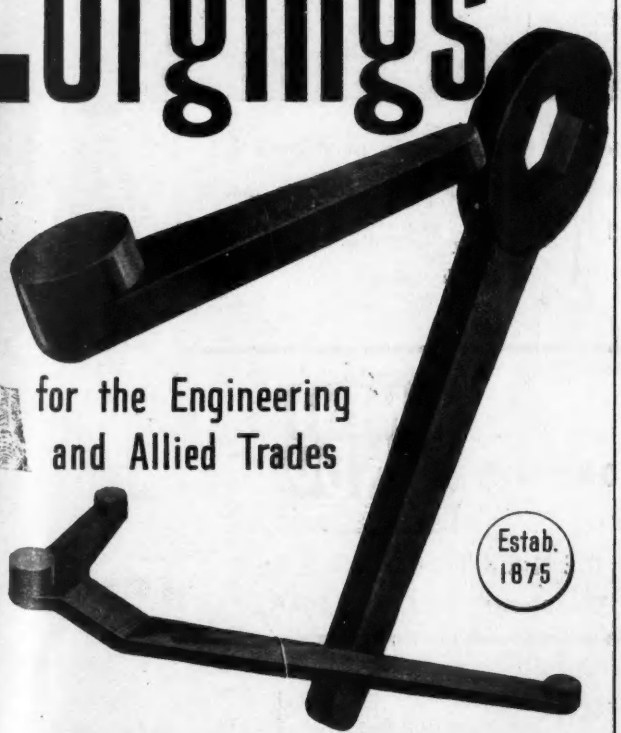

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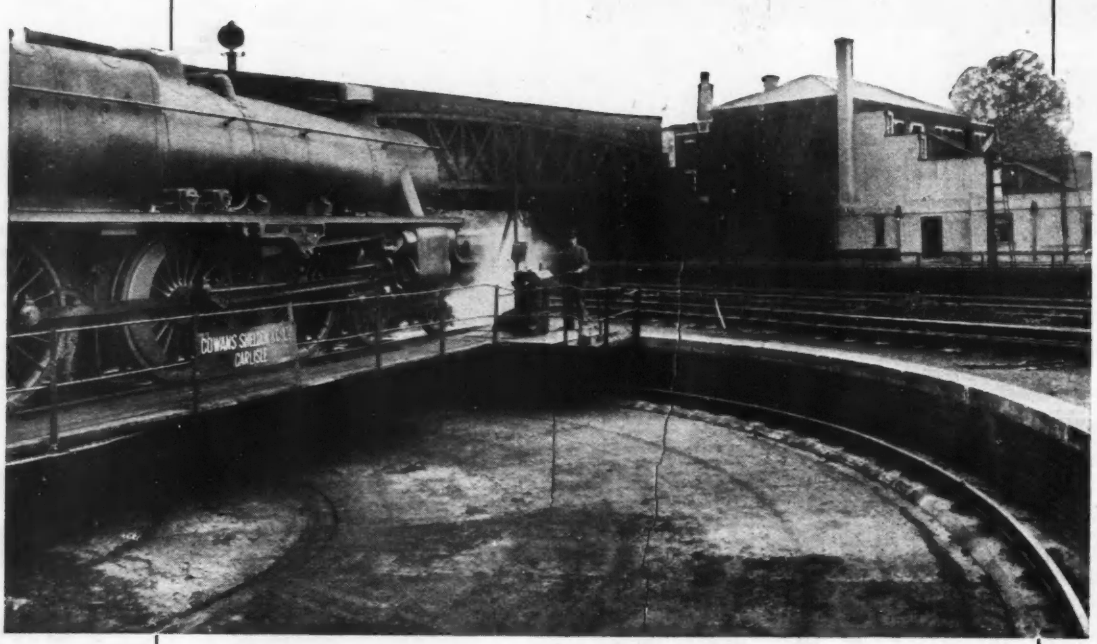

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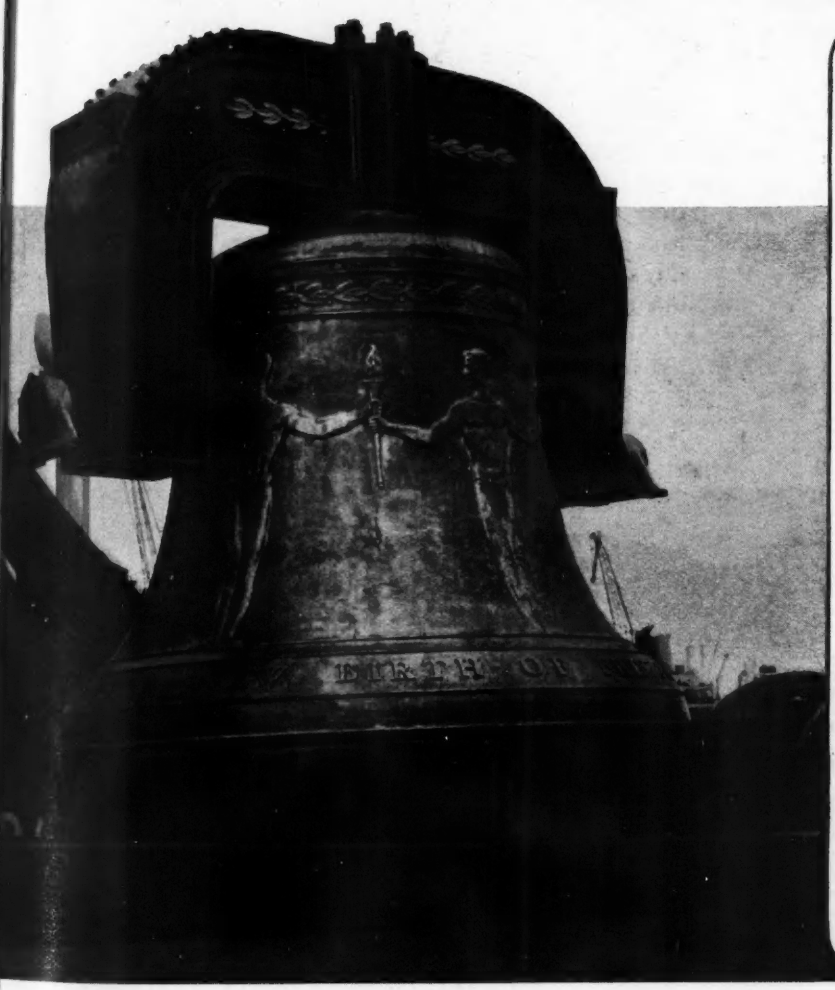

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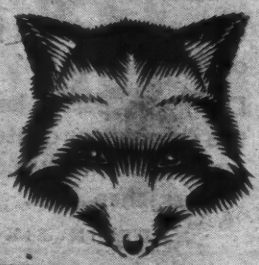

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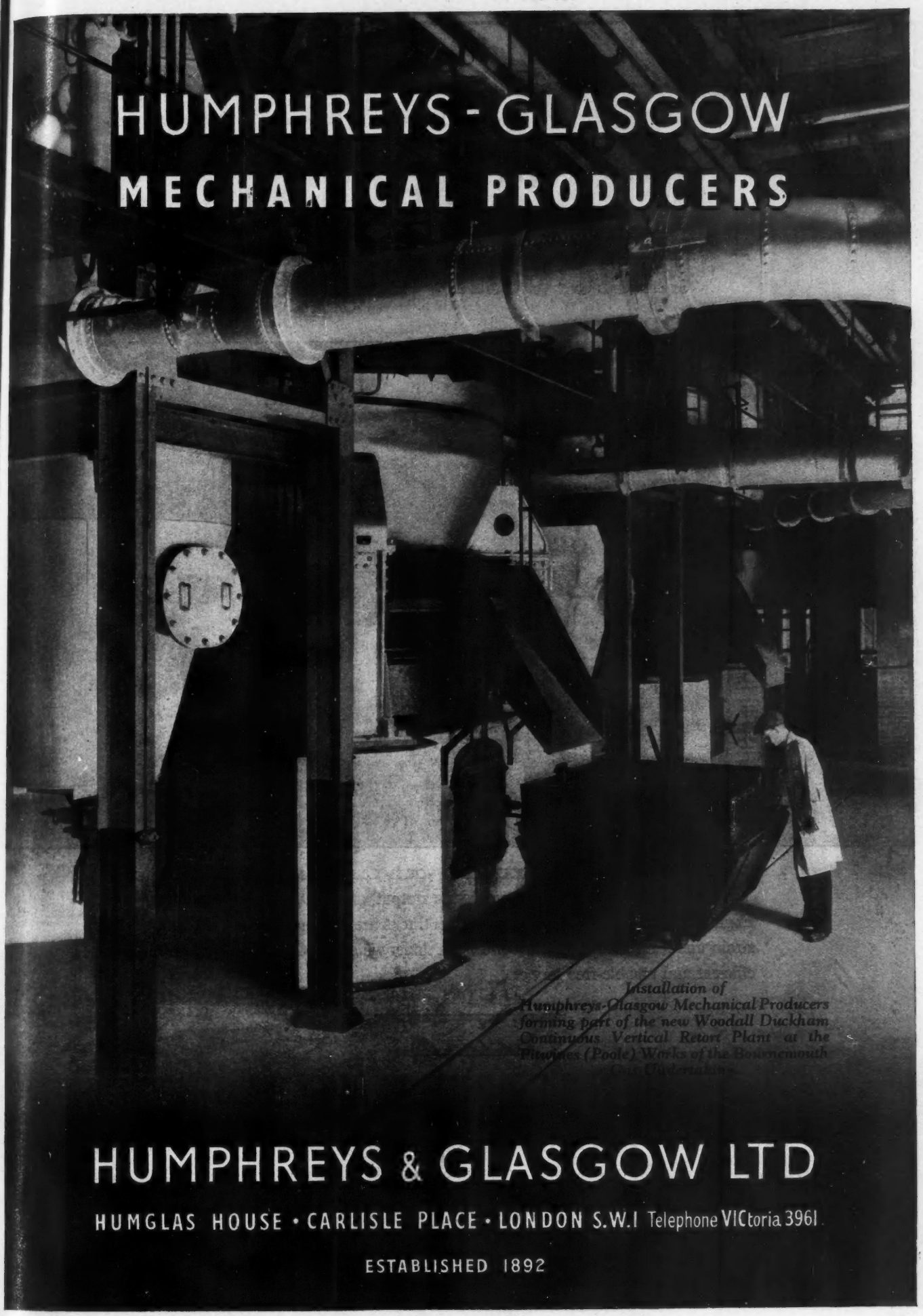

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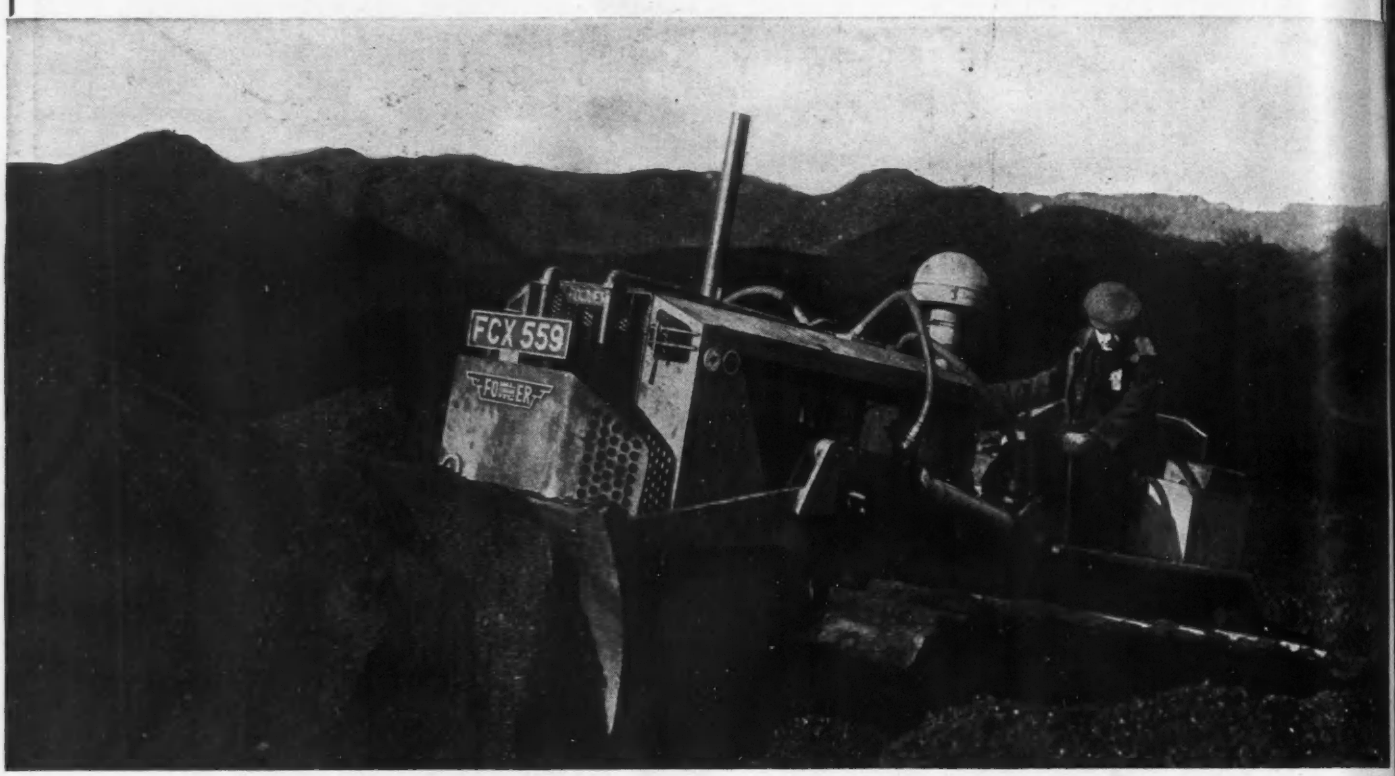

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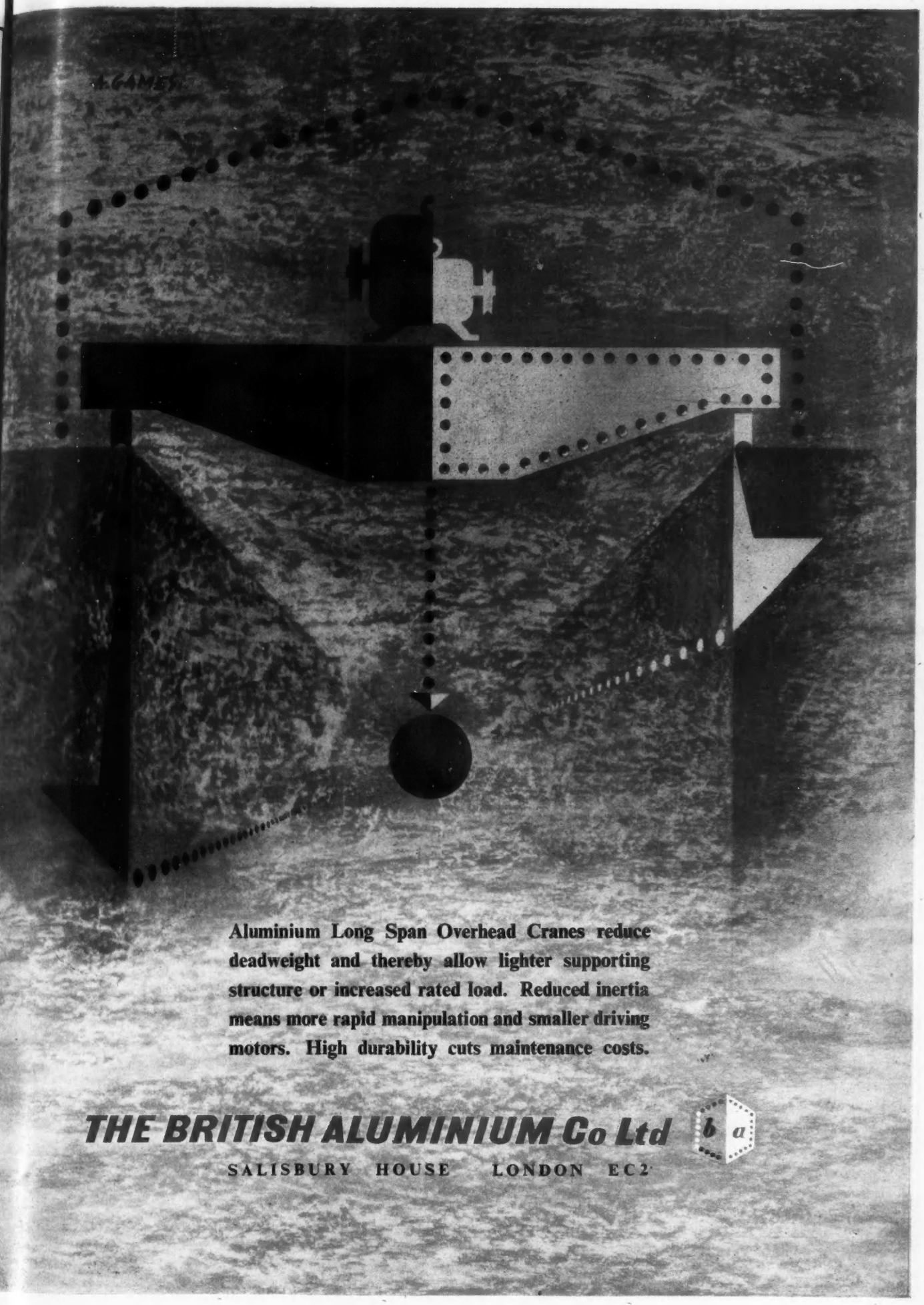

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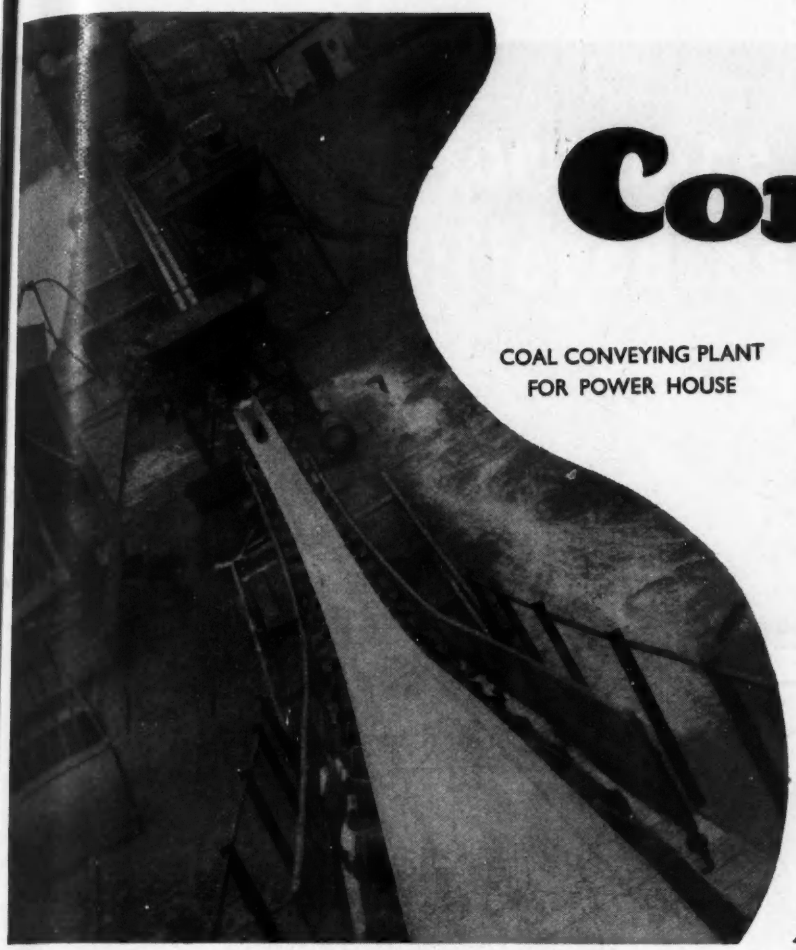

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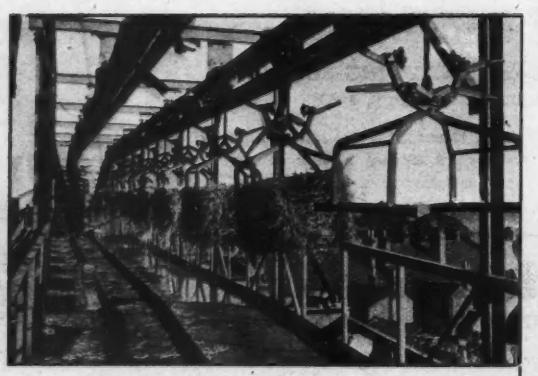

Conveying straw bales from wharves to mill at Bowater's — a KING dual duty overhead conveyor.

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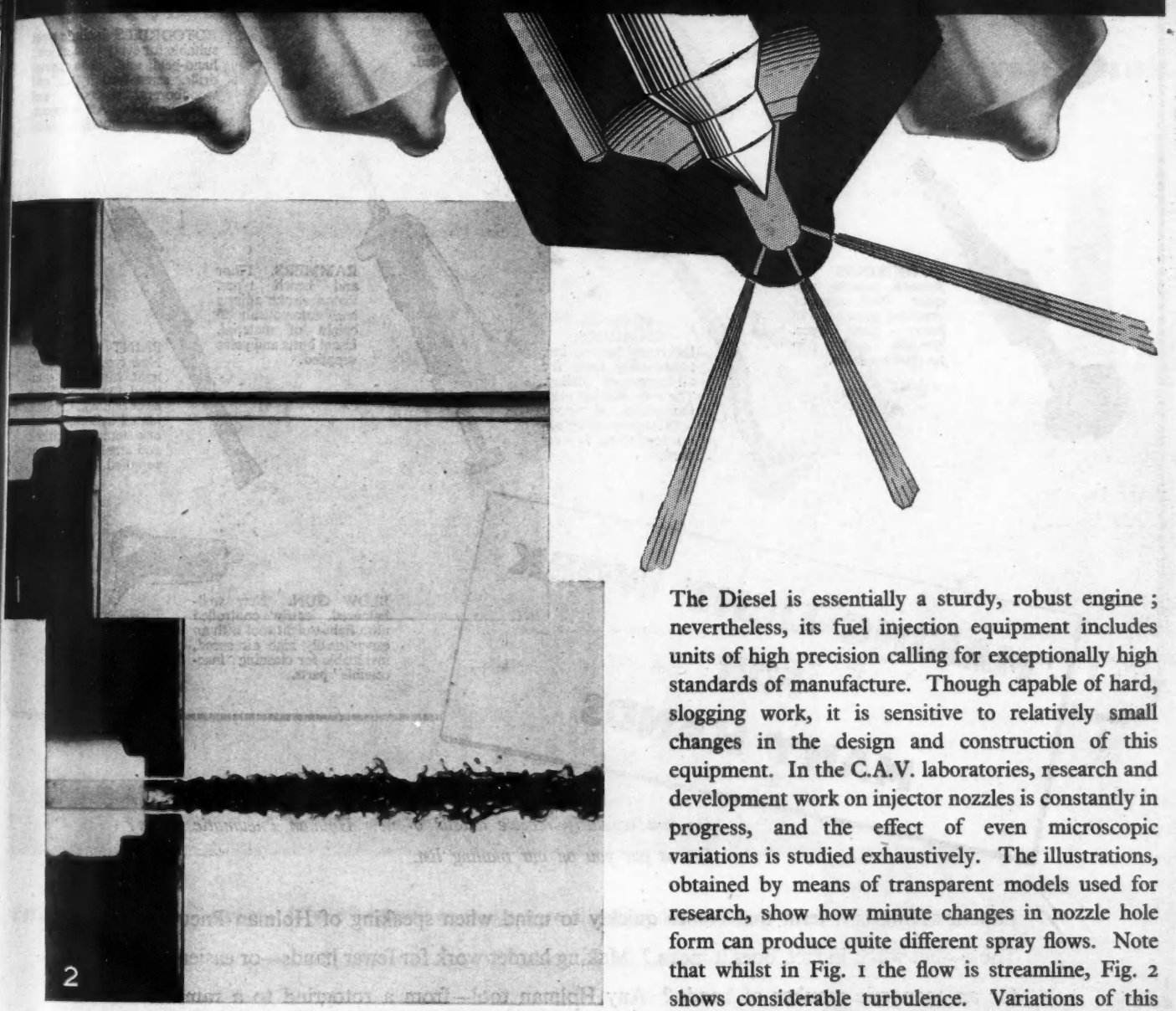

High speed photographs (exposure approx. 2 micro-seconds) of jets emerging from transparent nozzles, showing marked change in flow characteristics caused by microscopic differences in hole form. Slight variations in pressure can also cause similar differences.

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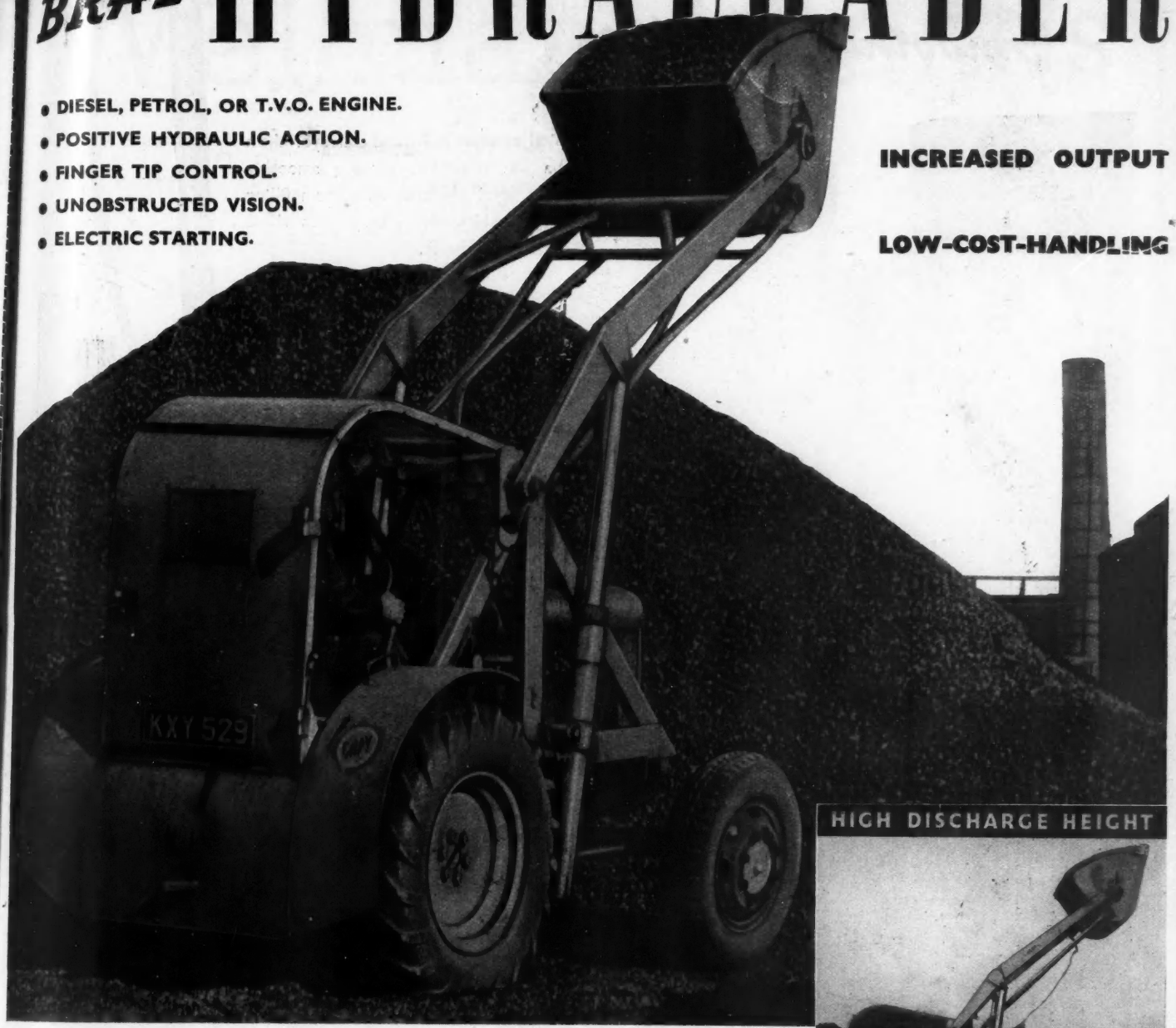

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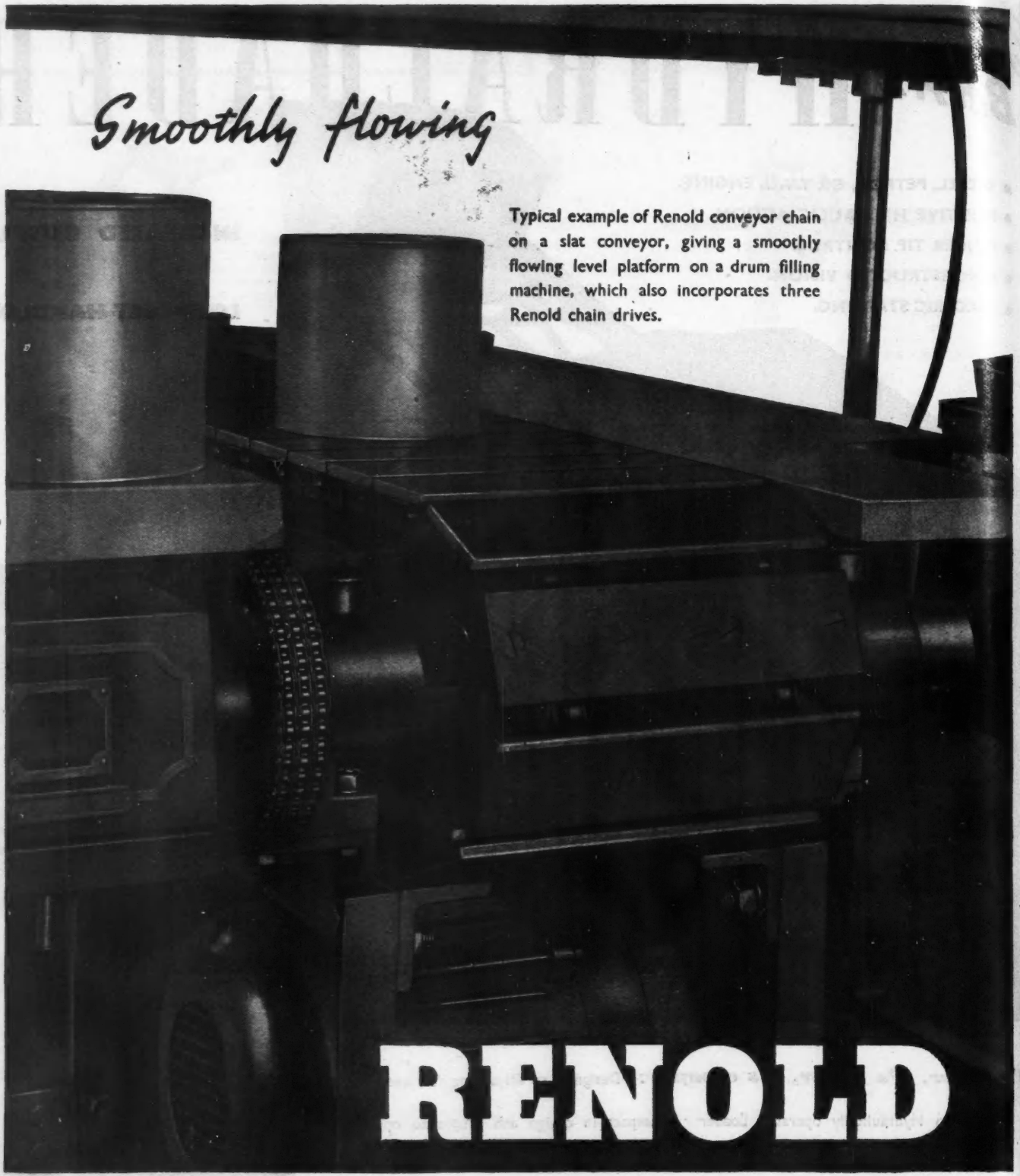

Typical example of Renold conveyor chain on a slat conveyor, giving a smoothly flowing level platform on a drum filling machine, which also incorporates three Renold chain drives.

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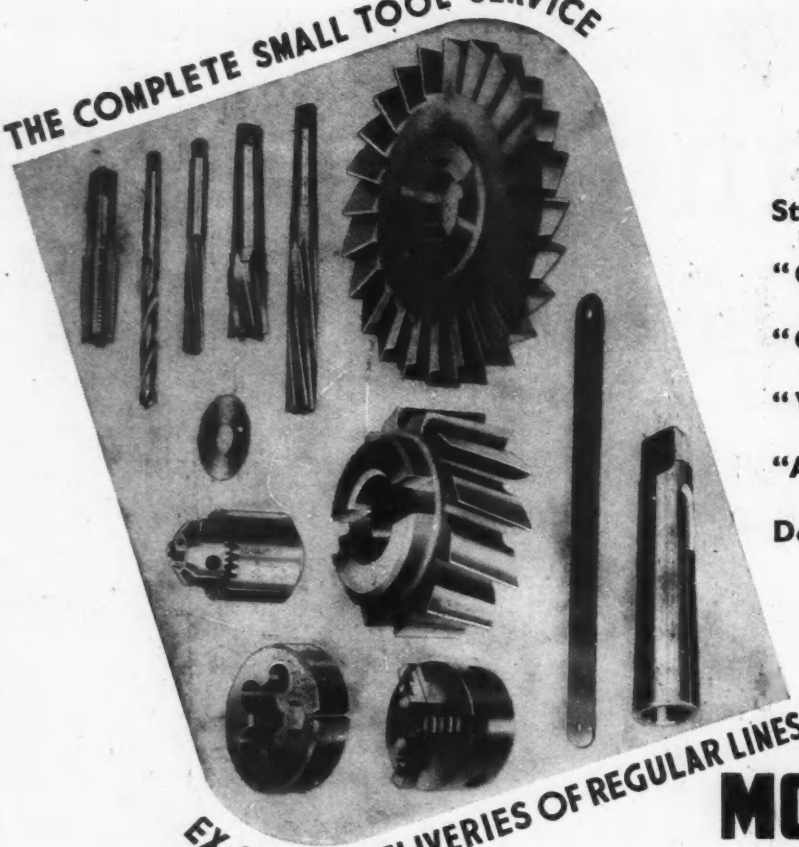

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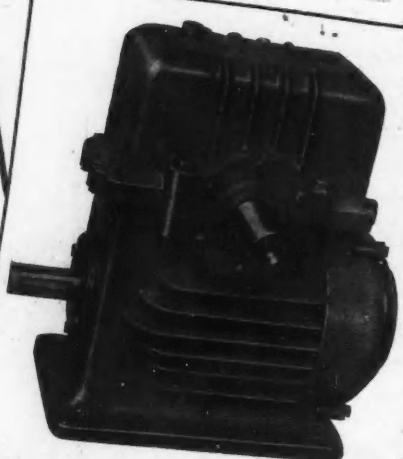
We manufacture this type of geared motor in six sizes for H.P.s between ¼ and 15 with output speed between 375 and 12 r.p.m. We can supply any make of motor with any type of enclosure, or we can fit your motors provided they are of the flange fixing pattern. This type of geared motor is also available with a vertical output shaft for driving stirrers, mixers, agitators, etc.

May we send you our catalogue?



This illustration shows a worm geared speed reducer which we produce with or without fan cooling in a range of sizes from 1¼" to 9" gear centres; standard ratios between 10-1 and 60-1 are available in each size. Ratios outside this range can also be supplied.

For a completely trouble free life under the most exacting conditions, you can depend on either of these two gear boxes and for that matter on any of the other many different types of speed reducers that we produce.

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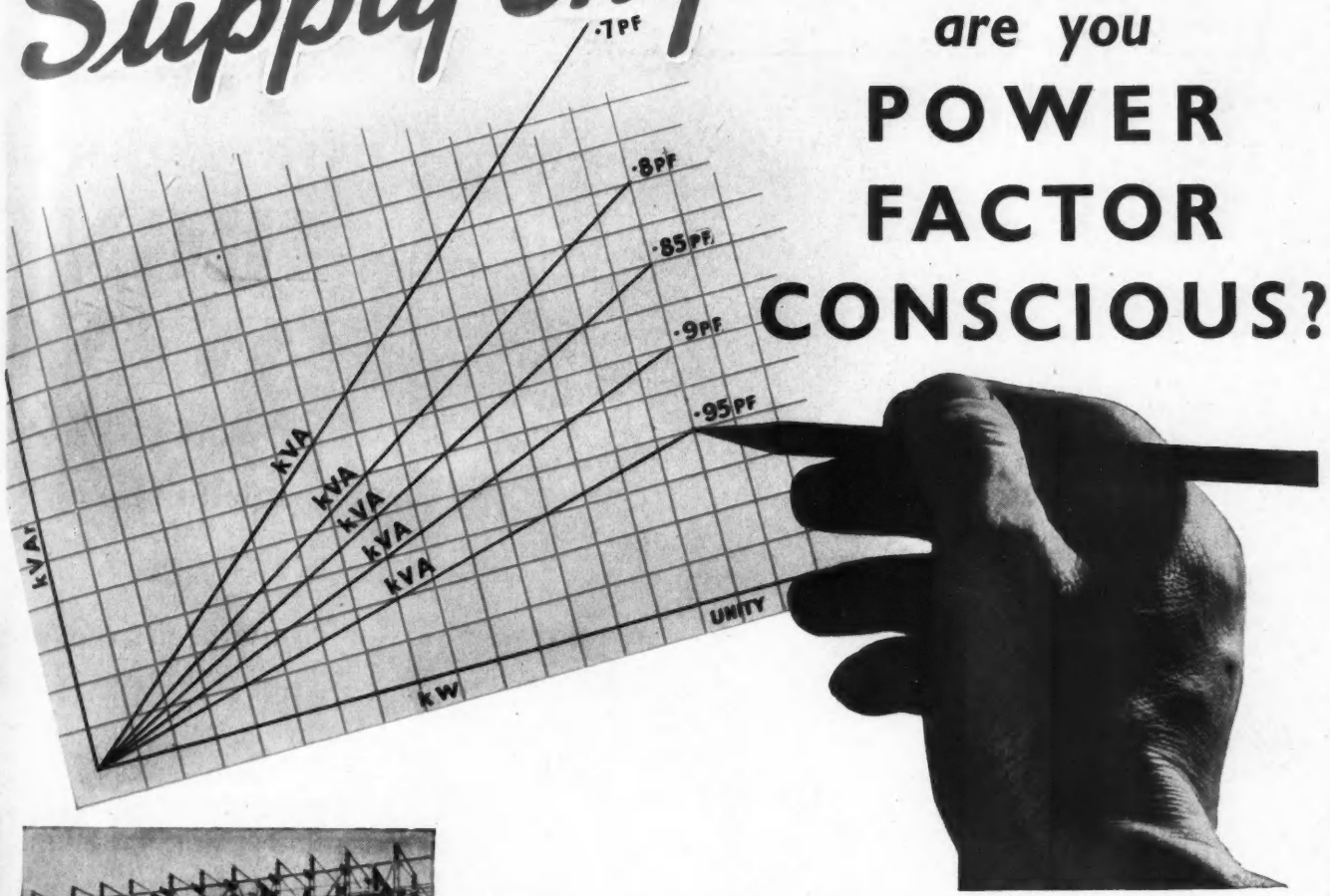
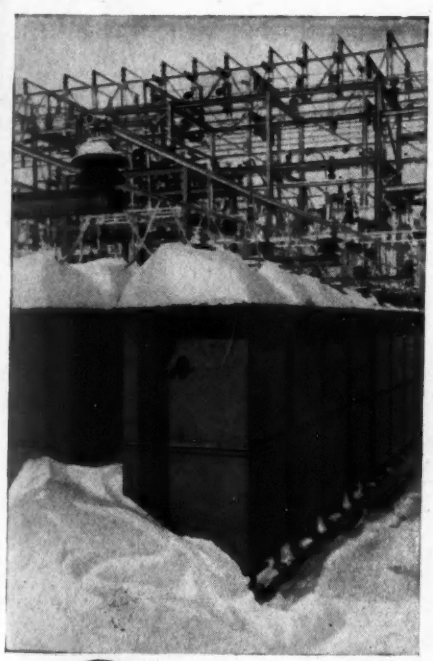
Supply Engineers — are you POWER FACTOR CONSCIOUS?





Do you think a P.F. of ·95 is good? Is a P.F. of ·8 tolerable? The idle component of the current is over 30% with the former and 60% with the latter. Neither is really good enough if you wish to deliver maximum power, minimise losses and reduce the voltage drop in your system to the lowest possible figure.

Have you considered using shunt capacitors to improve your power factor?

Today capacitors can be obtained as reliable and durable as the other components of your system . . . if you specify BICC Power Capacitors.

These high quality products are the result of nearly 40 years' research and development and have a guaranteed efficiency of not less than 99·87%. Unlike most other items of electrical apparatus, they require practically no maintenance.

They can be connected as individual units at motor terminals and distribution boards, and in small or large banks at secondary or main sub-stations.

The illustration shows a 20,250kVAr bank of BICC Capacitors supplied to the Aluminum Company of Canada Ltd. It comprises eighty-one 250kVAr single-phase units connected for operation at 10.3kV.

Further information is available in Publication 278T

B.I. Callender's

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This is the paving for factories and workshops where traffic is heavy and conditions severe. This is the flooring that cannot rock or disintegrate; that is free from dust, safe for operatives; that stands up to truck traffic; needs no maintenance; that is designed to stay put and keep level—"TRI-PEDAL," the triangular iron paving unit that makes the perfect permanent floor.

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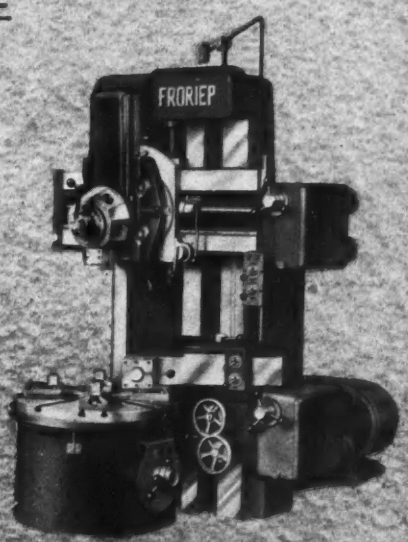

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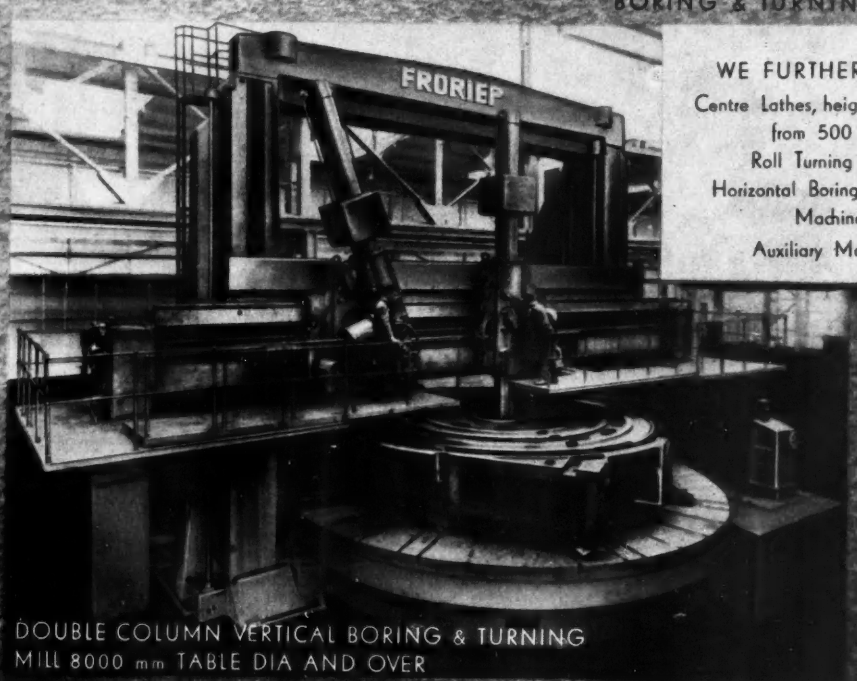

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MILL 8000 mm TABLE DIA AND OVER

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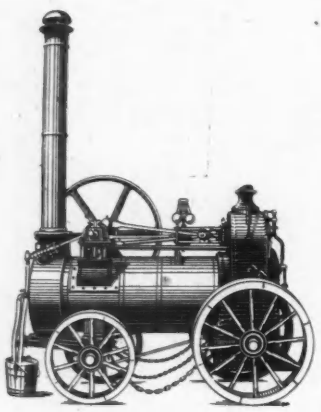


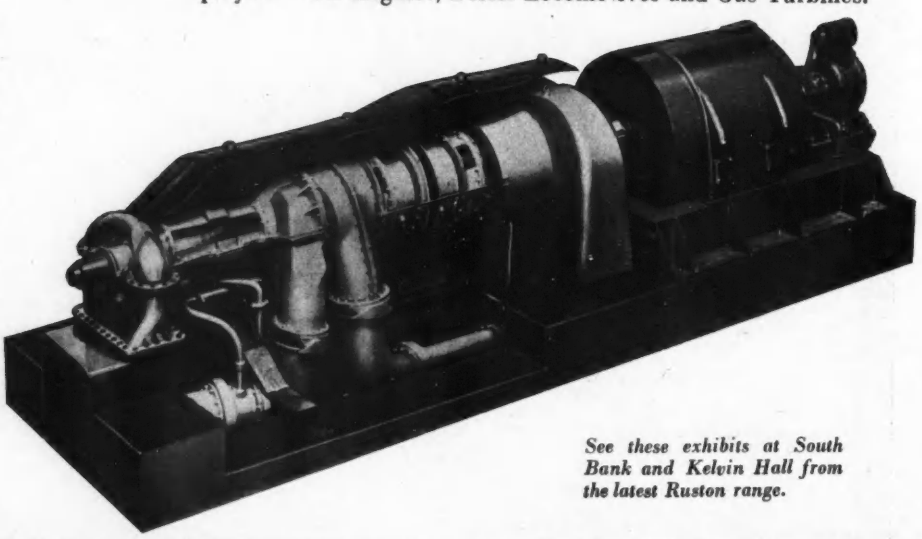
1851

The above illustration is from contemporary catalogues of the Hornsby Portable Steam Engine, awarded the Council Medal at the Great Exhibition of 1851.

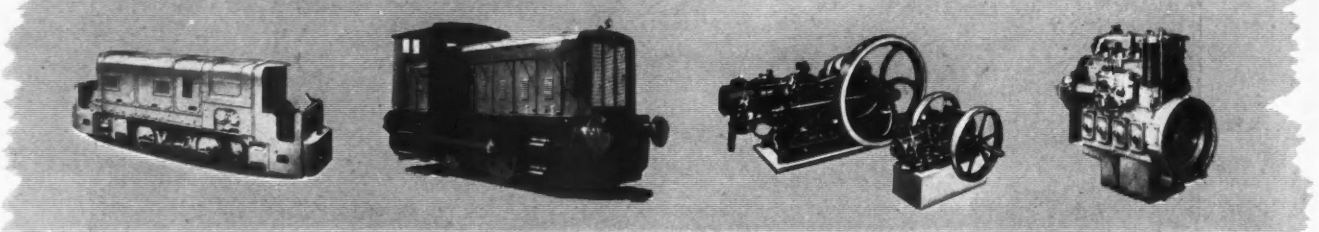
1951

At the Festival of Britain, the Ruston Gas Turbine, Locos and Engines are on display as illustrated at right and below.

FESTIVAL OF BRITAIN industrial exhibits in London and Glasgow concentrate in a small area many of the century's developments in industrial power. At the 1851 Great Exhibition, where steam equipment of the Ruston family won their first laurels, a tradition of service to industry was established which helped to inspire the world's first commercially successful oil engine, marketed by the firm in 1892. Consolidation of that tradition is demonstrated in tangible form at this year's Festival where the latest examples of power for industry are displayed — Oil Engines, Diesel Locomotives and Gas Turbines.



See these exhibits at South Bank and Kelvin Hall from the latest Ruston range.



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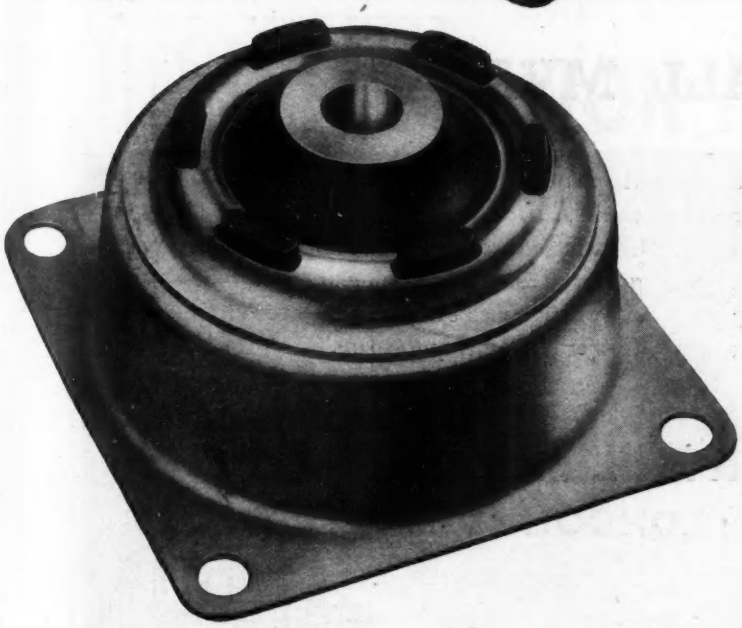
That's the chap....

...a Silentbloc Anti-Vibration Instrument mounting



When critical factors in the choice of a resilient mounting are size and weight as well as performance and correct degree of flexibility this Silentbloc unit has all the answers. It is light, compact, easily fitted and the controlled deflection given by the patented rubber diaphragm remains constant.

Available from stock in a range of sizes for loads between one and 45 lbs.

Our Technical Department will be glad to give designers the benefit of their wide experience in protecting sensitive instruments from vibration.

Silentbloc Instrument Mountings can be fitted in a number of ways and supplied with or without the pedestal type flange shown above. The illustration is four times larger than the mounting.

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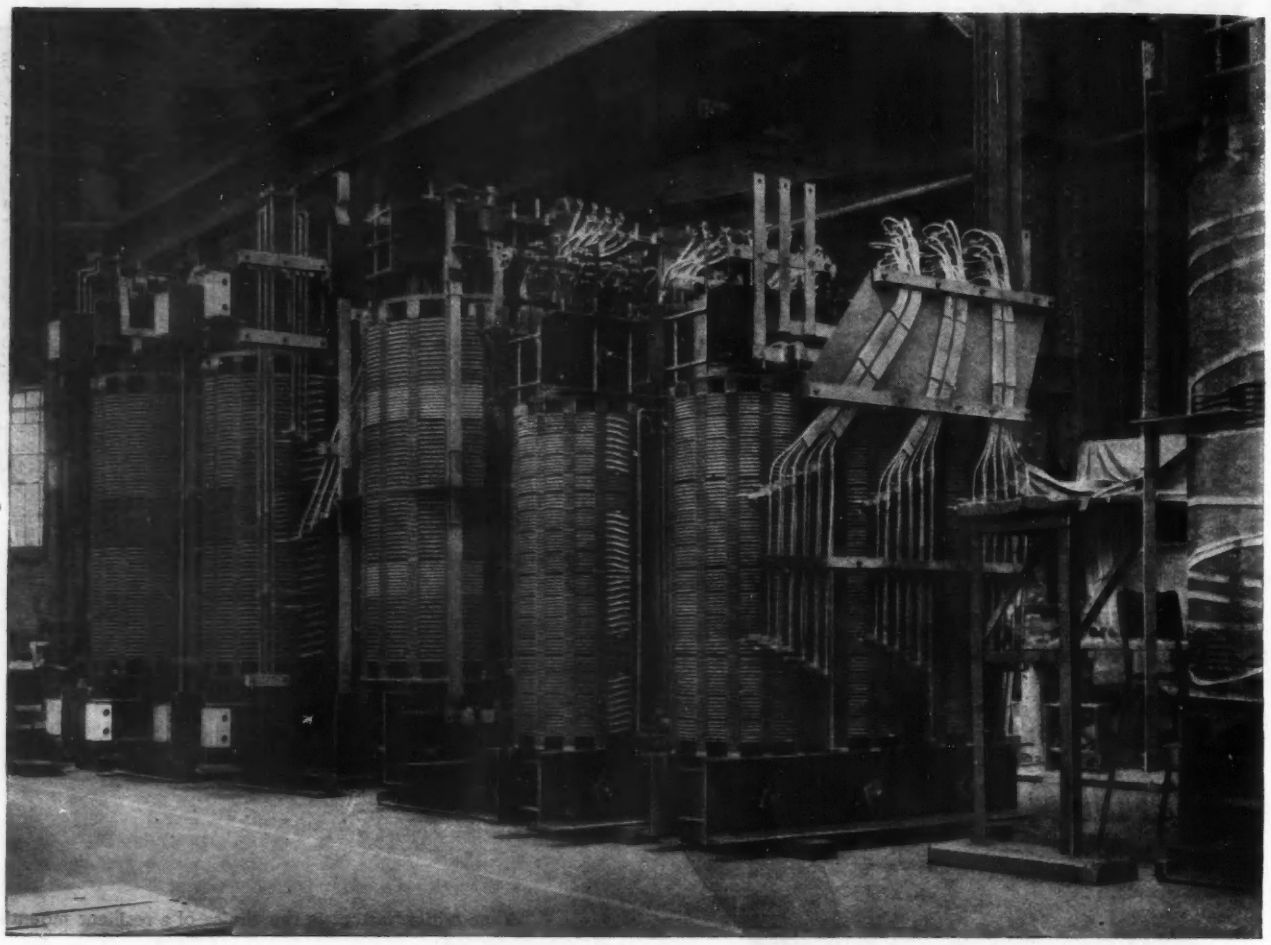

NOT ALL MVA's

Not all the transformers we build are measured in MVA, but our reputation for building transformers with "plenty to spare" certainly seems to be attracting a lot of large jobs our way. The three 15 MVA units on the left are for the B.E.A.; the two 4 MVA units in the centre are for the N.C.B.; while the 10 MVA unit just showing on the right is for Australia. When you're needing a big unit—or a little one—it's worth remembering that a J. & P. transformer has "plenty to spare."

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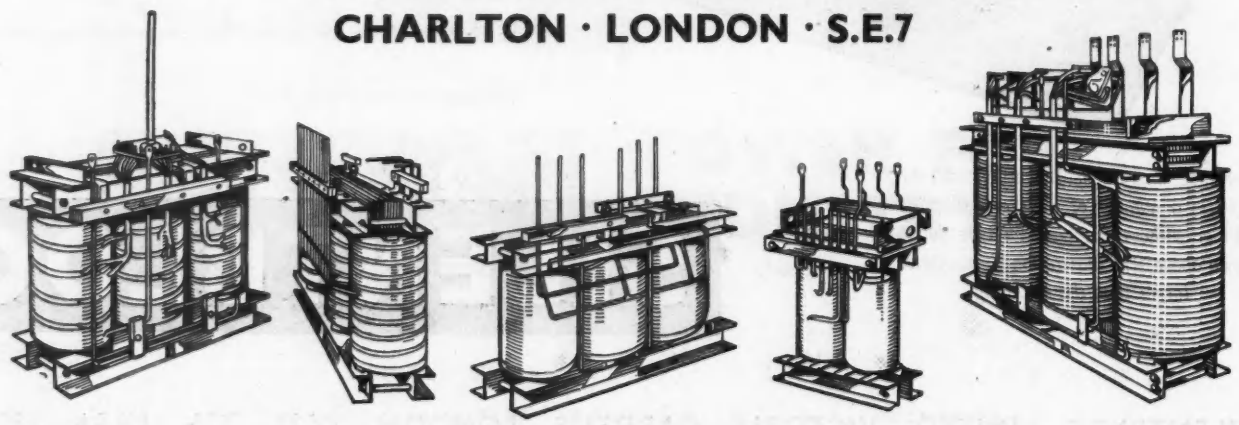
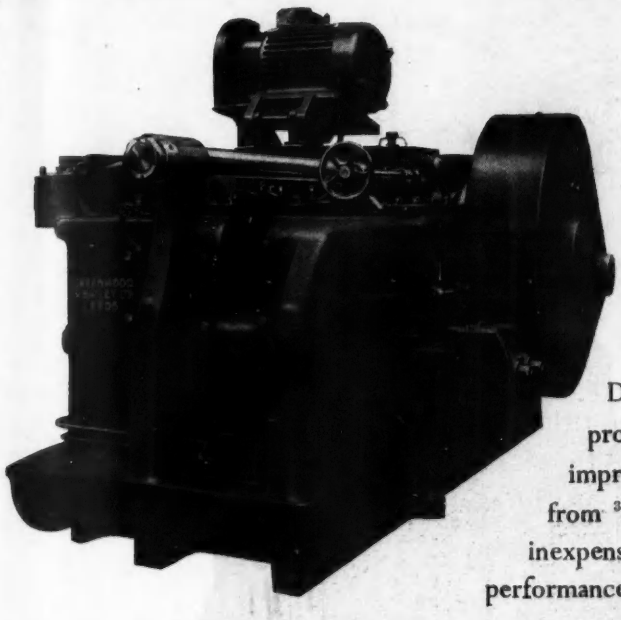


UPSETTING



If it's upsetting the job calls for a Greenbat hot forging machine. Designed for the hot forging of metal bars by the 'upsetting' process and to give a product of high accuracy and sharpness of impression, this type of machine is available in several sizes to take bars from 3/4" to 4" diameter. Tools are simple, durable and comparatively inexpensive and the operator need not be highly skilled. Full details of performance and applications on request.

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1¼ MILLION TONS ON ONE BELT

"The photograph shows part of an installation at a Coking Plant in South Yorkshire, which has handled over 1¼ million tons of coal since October 1945. The original belting is still in excellent condition without signs of wear on either the covers or edges. The idlers have given trouble-free service since they were installed."

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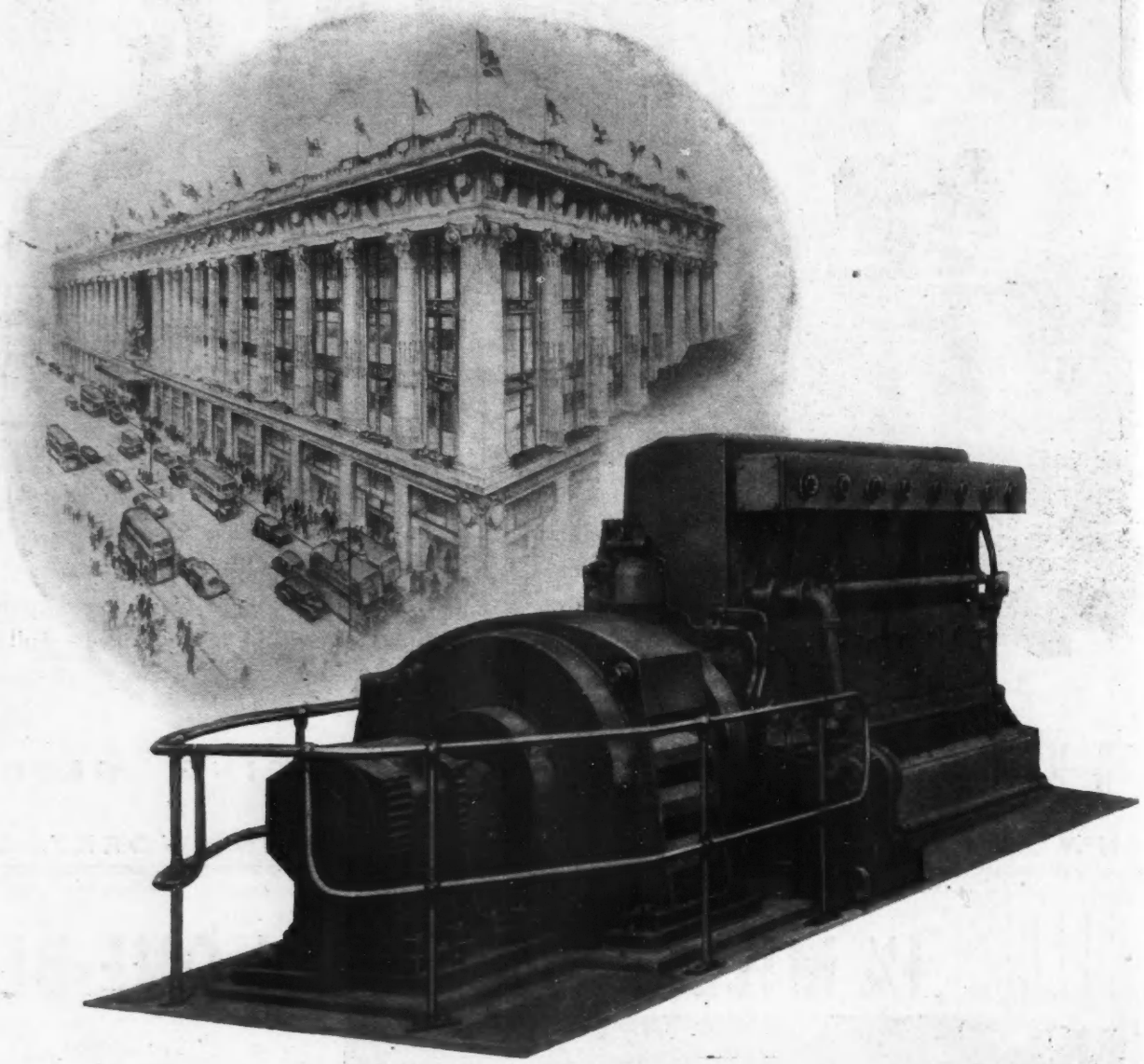

DIESEL POWER AT SELFRIDGES

Emergency power for this famous store is provided by three Mirrlees 250 k W generating sets installed in the lower basement. Waste heat recovery plant is included in the installation.
Consultant : W. Howes, M.I.Mech.E., M.I.E.E.
Industrial diesel engines from 135—2880 B.H.P

Mirrlees

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M24

FOR DISPOSAL

A.C. MOTORS

400/440 volts, 3-phase, 50 cycles.

No.	H.P.	R.P.M	Rotor	Type	Bearings	Maker	Comments
1	95	485	S.R.	Prot.	B.B.	L.D.M.	With new starter
1	75	733	S.C.	Prot.	R.O.	Holmes	
1	70	735	S.R.	Prot.	B.B.	E.E.C.	With starter and rails
1	60	480	S.R.	Prot.	B.B.	G.E.C.	With starter
1	55	1460	S.R.	Prot.	B.B.	C. Parkinson	With starter
1	35	720	S.R.	Prot.	B.B.	Veritys	With starter
1	30	960	S.C.	Prot.	B.B.	E.E.C.	With starters
1	30	715	S.C.	Prot.	B.B.	E.E.C.	With starter
1	27½	725	S.C.	Prot.	B.B.	E.E.C.	With starter
8	25	730	S.C.	Prot.	B.B.	C. Parkinson	With starters
1	20	705	S.R.	Prot.	B.B.	G.E.C.	With starter
3	17½	960	S.C.	P.V.	B.B.	Higgs	With starters
1	10	1500	S.R.	T.E.S.C.	B.B.	Brook	With starter
1	7½	960	S.R.	Prot.	B.B.	G.E.C.	With starters. NEW
5	2	3000	S.C.	Prot.	B.B.	L.D.C.	
5	1½	950	S.C.	Prot.	B.B.	Met.-Vick.	380/420 volt
31	15/7½	945/478	S.C.	Prot.	B.B.	L.D.C.	Pole changing
5	1	960/31	S.C.	Prot.	B.B.	M. & Platt	Geared, vertical up
1	½	100	S.C.	T.E.	B.B.		Geared. NEW
1	½	52	S.C.	T.E.	B.B.		Geared. NEW
1	1½	75	S.C.	T.E.	B.B.		Geared. NEW
1	1½	39	S.C.	T.E.	B.B.		Geared. NEW
1	1	64	S.C.	T.E.	B.B.		Geared. NEW
1	1	26	S.C.	T.E.	B.B.		Geared. NEW

230 volts, single phase, 50 cycles.

1	¼	50	R.I.	T.E.	B.B.		Geared. NEW
1	¼	61	R.I.	T.E.	B.B.		Geared. NEW
3	2	100	R.I.	T.E.	B.B.		Geared. NEW
2	¾	50	R.I.	Prot.	B.B.		Geared
1	1	65	S.C.	Prot.	B.B.		Geared capacitor
1	1½	1445	R.I.	Prot.	B.B.		240/460 volts
1	2	1500	S.C.	Prot.	B.B.		Split-phase, with starter
1	2	1000	S.C.	Prot.	B.B.		Split-phase, with starter
1	2	3000	S.C.	F.L.P.	B.B.		Split-phase
1	3	1500	S.C.	Prot.	B.B.		Split-phase, with starter

D.C. GENERATORS

ONE RECONDITIONED 36-kW, 220/230 volts D.C. DIESEL ENGINE DRIVEN GENERATING SET, comprising Harland compound-wound, 1350 r.p.m. generator, direct coupled to Paxman-Ricardo vertical four-cylinder, type 4.R.Q. engine, mounted on bed-plate and complete with switchboard.

TWO RECONDITIONED 18-kW, 100 volts D.C. DIESEL ENGINE DRIVEN GENERATING SETS, comprising L.D.C. compound-wound, 1000 r.p.m. generator, direct coupled to Ruston vertical four-cylinder radiator-cooled engines, mounted on bed-plate and complete with switchboards.

ONE MOTOR GENERATING SET, comprising 55 H.P., protected type, slip-ring motor, by C. Parkinson, 400/440 volts, three-phase, 50 cycles, 1460 r.p.m., direct coupled to protected type compound-wound D.C. generator, 210/300 volts, 105 amps., on bed-plate, and complete with stator and rotor starter for the A.C. motor.

ONE RECONDITIONED 5-kVA. 230 volts, single-phase, 50 cycles, DIESEL ENGINE DRIVEN ALTERNATING SET, comprising Higgs protected type alternator, with exciter, direct coupled to Crossley vertical single-cylinder diesel engine, with radiator and fan cooling, on bed-plate with switchboard.

NEW SINGLE-SPEED GEARED MOTORS

TOTALLY ENCLOSED OR DRIP-PROOF ENCLOSURE.

SUITABLE FOR OPERATION OFF A: 400/440 volts, three-phase, 50-cycles supply.
100/250 volts, single-phase, 50 cycles.
100/250 volts D.C., shunt, compound or series.

HORSE-POWER AVAILABLE: ¼, ½, ¾, 1, 1½ and 2 H.P.

FINAL SPEED AVAILABLE: 480, 436, 406, 362, 350, 300, 280, 262, 245, 235, 220, 210, 200, 175, 156, 150, 135, 117, 110, 100, 88, 80, 75, 70, 64, 61, 53, 50, 44, 39, 34, 30, 29, 26 r.p.m.

Also low range of speed between ¼ and 15 r.p.m. at 100ft.-lb. torque, and from 0·37 to 9·3 r.p.m. at 200ft.-lb. torque, 0·47 to 13 r.p.m. output at 800ft.-lb. torque, and up to 7 r.p.m. at 1500ft.-lb. torque.

MISCELLANEOUS

SIX NEW HAND OPERATED NON DRAW OUT OIL BREAK CIRCUIT BREAKERS, by G.E.C. 100 amp., 400/440 volts, 3-phase, 50 cycles. With no volt and overload releases.

ONE TWIN GLASS BULB MERCURY ARC RECTIFIER, by B.T.H., input 6600 volts, three-phase, 50 cycles; output 150 kW., 460 volts D.C. With two rectifier cubicles, each 75 kW., 230 volts, 326 amps., with link, carrier, cooling fan and motor, control panel, transformer and two bulbs. Complete with D.C. switchboard and A.C. circuit breaker.

If the electrical equipment you need is not listed, please let us have details of your requirements, as the above is an abbreviated list only of the very large stock held of A.C. and D.C. motors, D.C. generators, A.C. and D.C. starters, and various other equipment.

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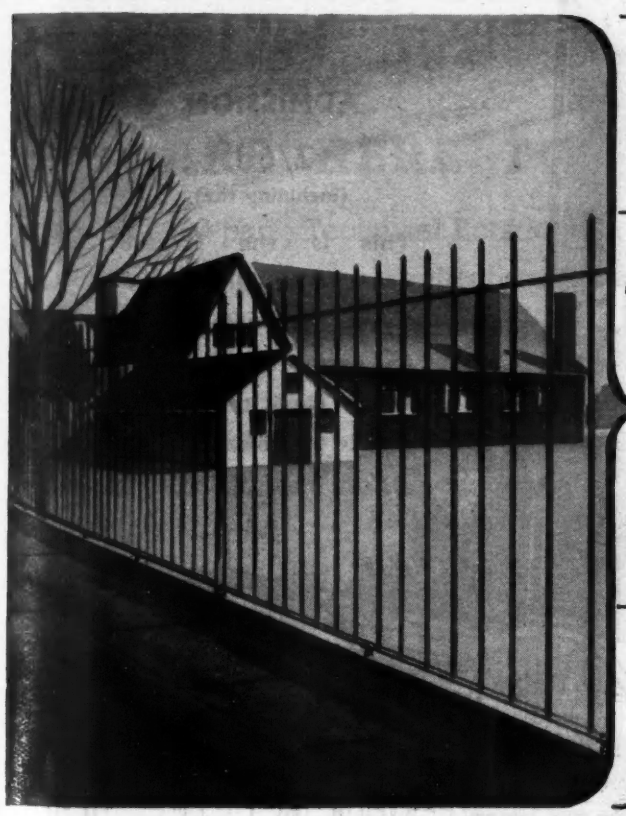

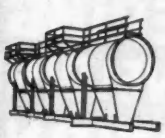

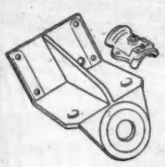

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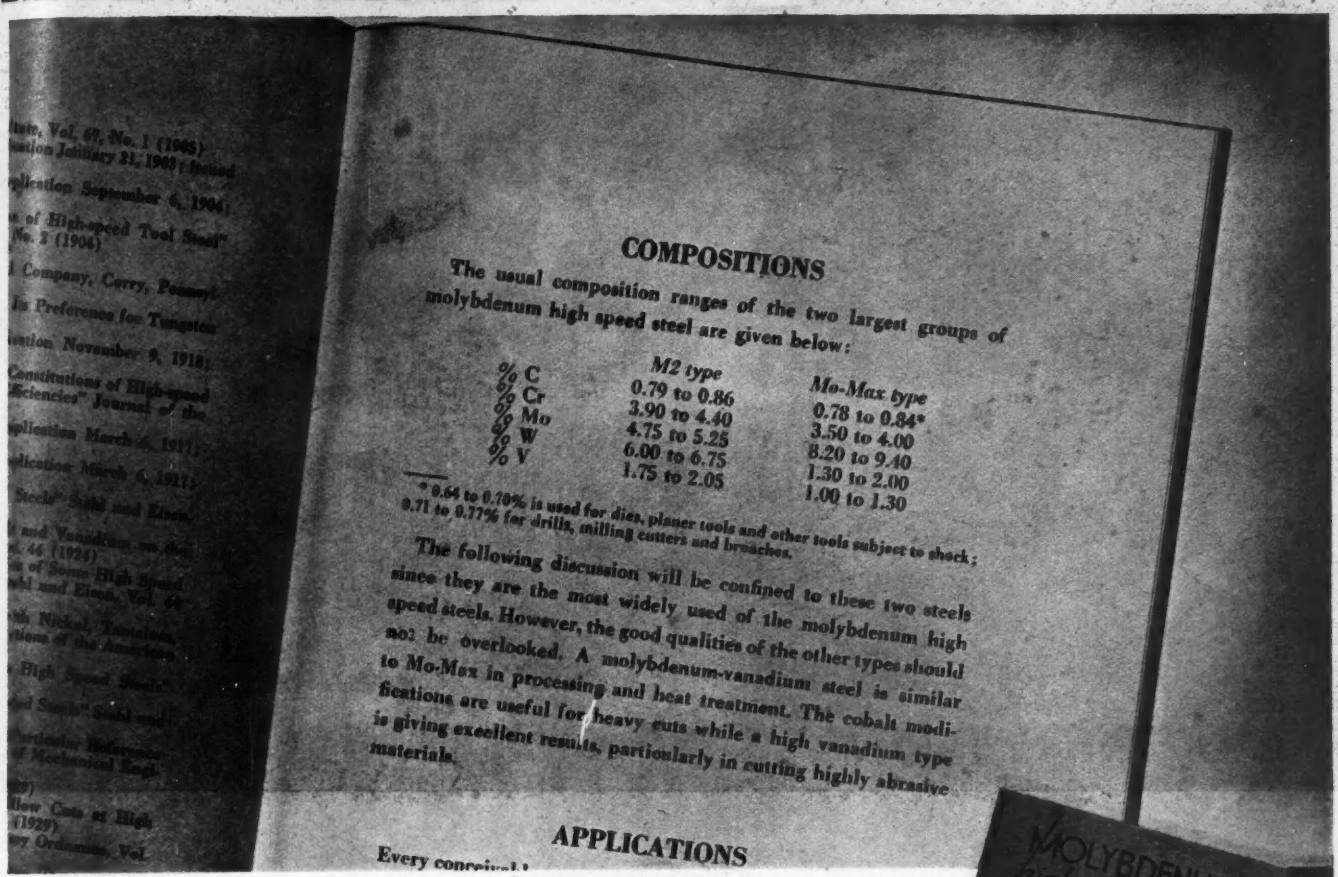
MOLYBDENUM HIGH SPEED STEELS



COMPOSITIONS

The usual composition ranges of the two largest groups of molybdenum high speed steel are given below:

	M2 type	*Mo-Max type*
% C	0.79 to 0.86	0.78 to 0.84*
% Cr	3.90 to 4.40	3.50 to 4.00
% Mo	4.75 to 5.25	8.20 to 9.40
% W	6.00 to 6.75	1.30 to 2.00
% V	1.75 to 2.05	1.00 to 1.30

* 0.64 to 0.70% is used for dies, planer tools and other tools subject to shock; 0.71 to 0.77% for drills, milling cutters and broaches.

The following discussion will be confined to these two steels since they are the most widely used of the molybdenum high speed steels. However, the good qualities of the other types should not be overlooked. A molybdenum-vanadium steel is similar to Mo-Max in processing and heat treatment. The cobalt modifications are useful for heavy cuts while a high vanadium type is giving excellent results, particularly in cutting highly abrasive materials.

APPLICATIONS

Every conceivable

—ARE HERE TO STAY

This 30 page Technical Booklet, which deals with compositions, applications, performance and treatment, gives you some of the reasons why.

Write now for a copy. It is available free on request to tool manufacturers and users.

Climax Molybdenum Company of Europe Ltd.

MOLY

Technical enquiries for this book, preferably with full details of the projected application of Molybdenum steel, should be addressed to:

99 Pinstone St. Sheffield, 1.

(Registered Office : **2-3 Crosby Square, London E.C.3.)**

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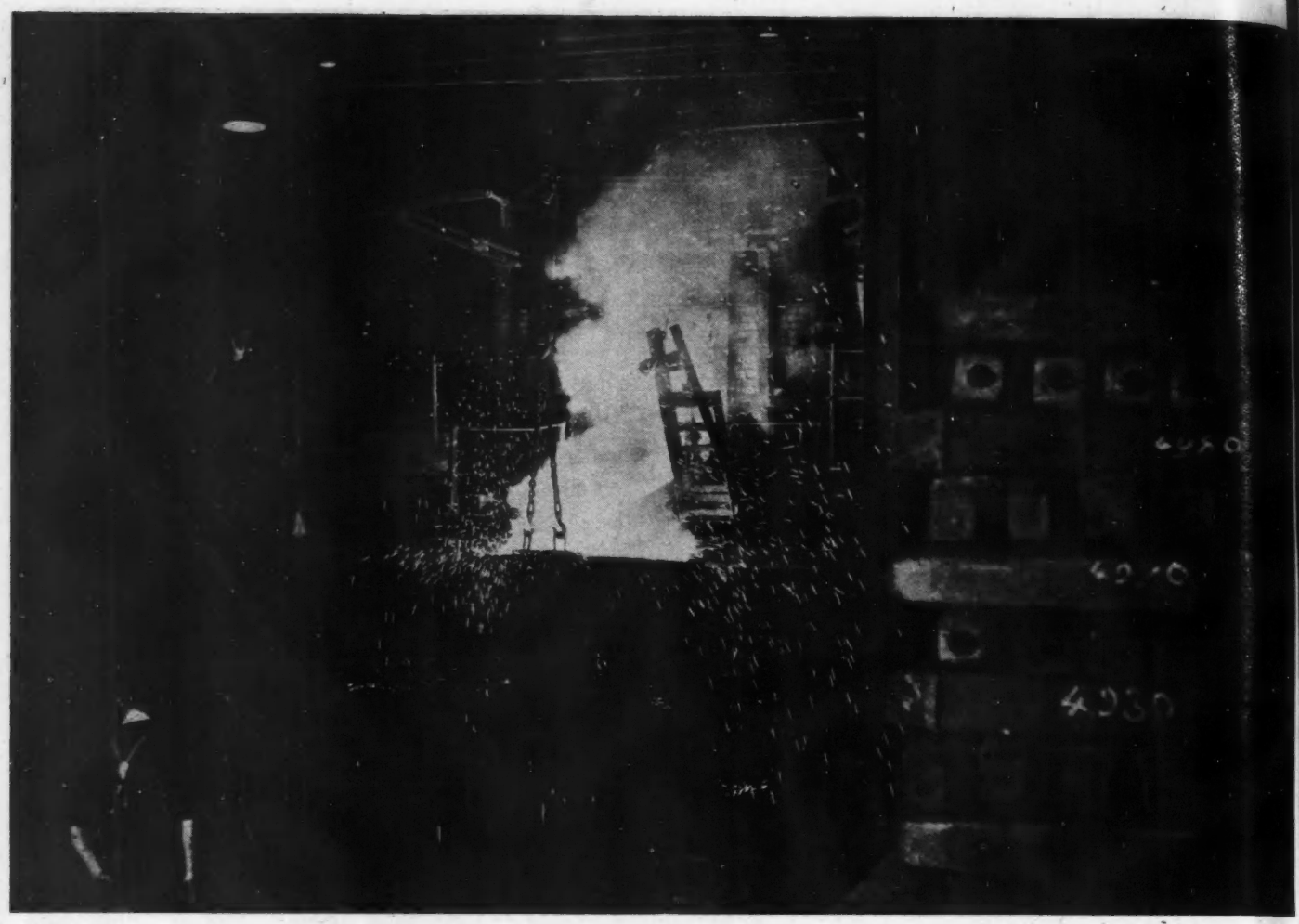

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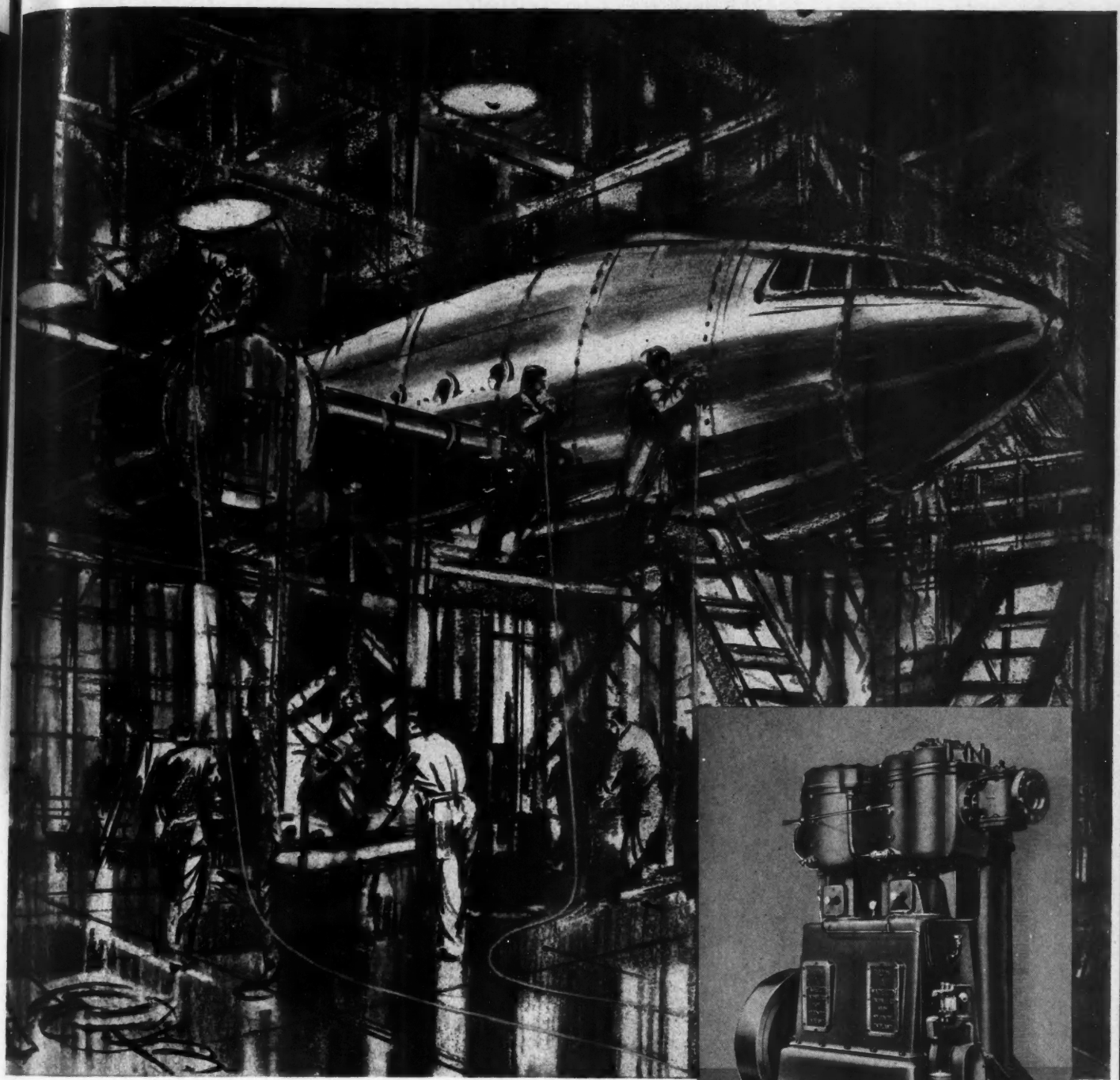

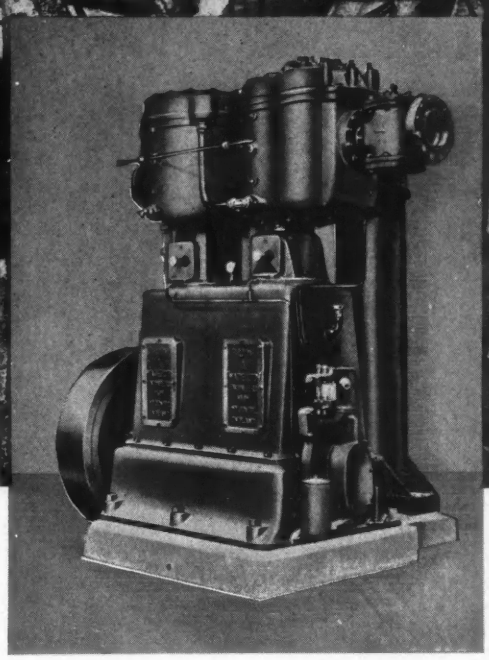

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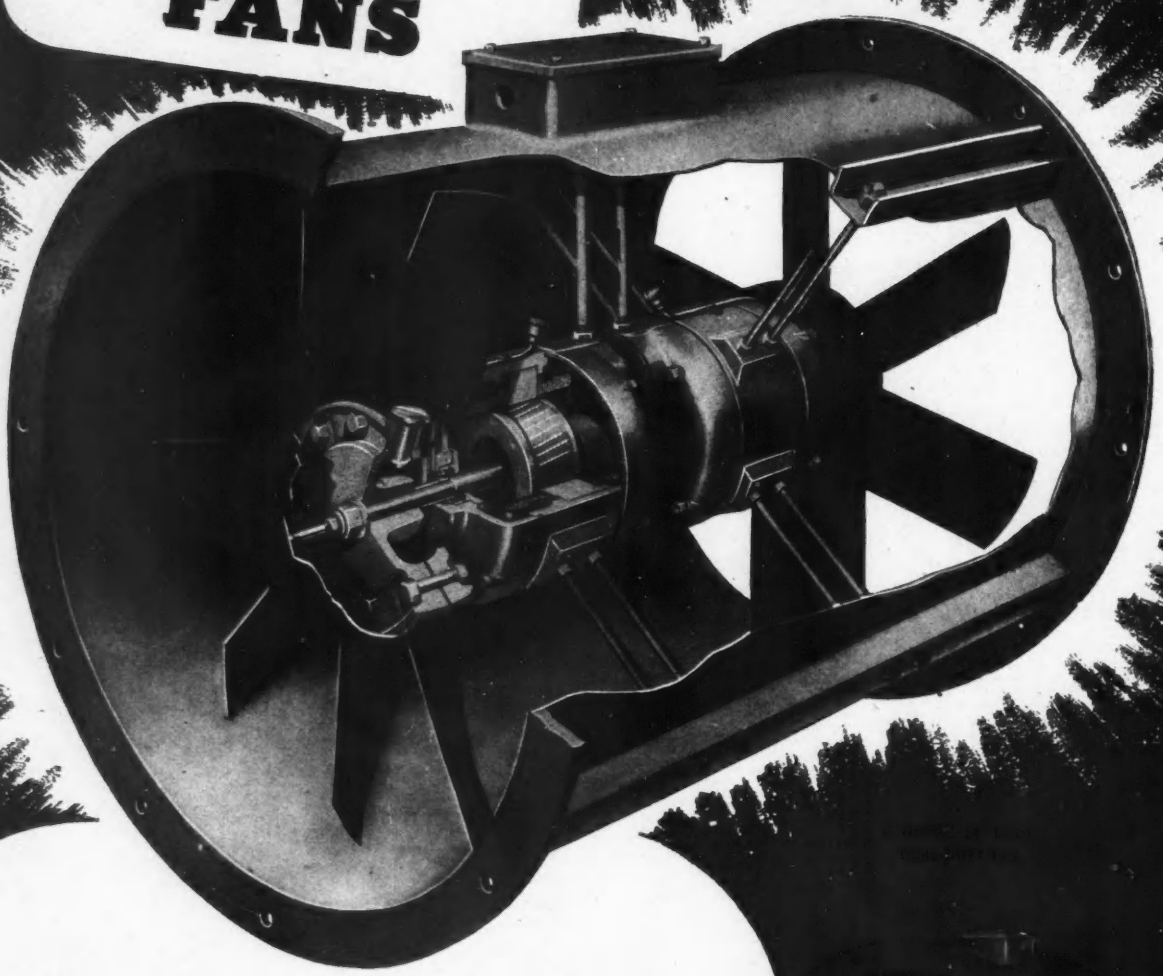

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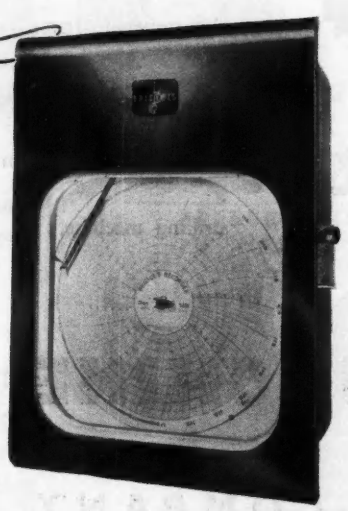

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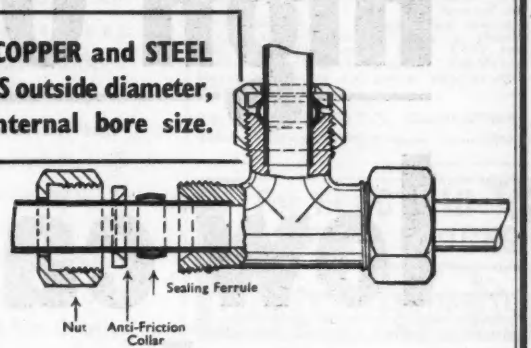

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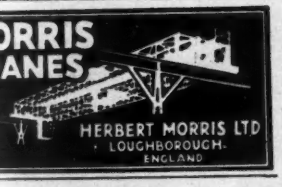

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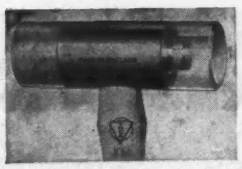

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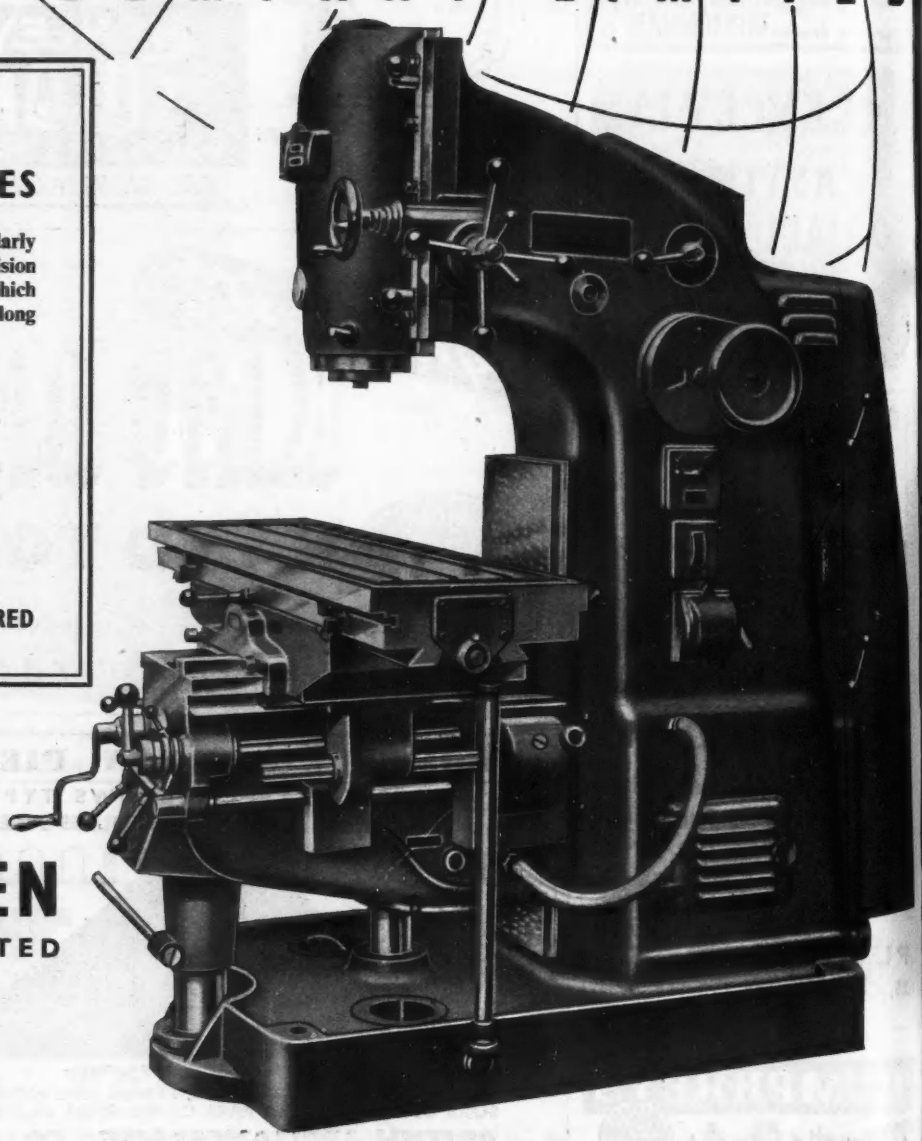

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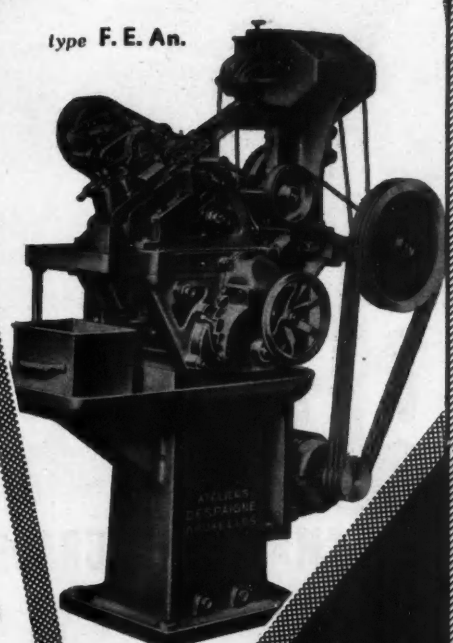

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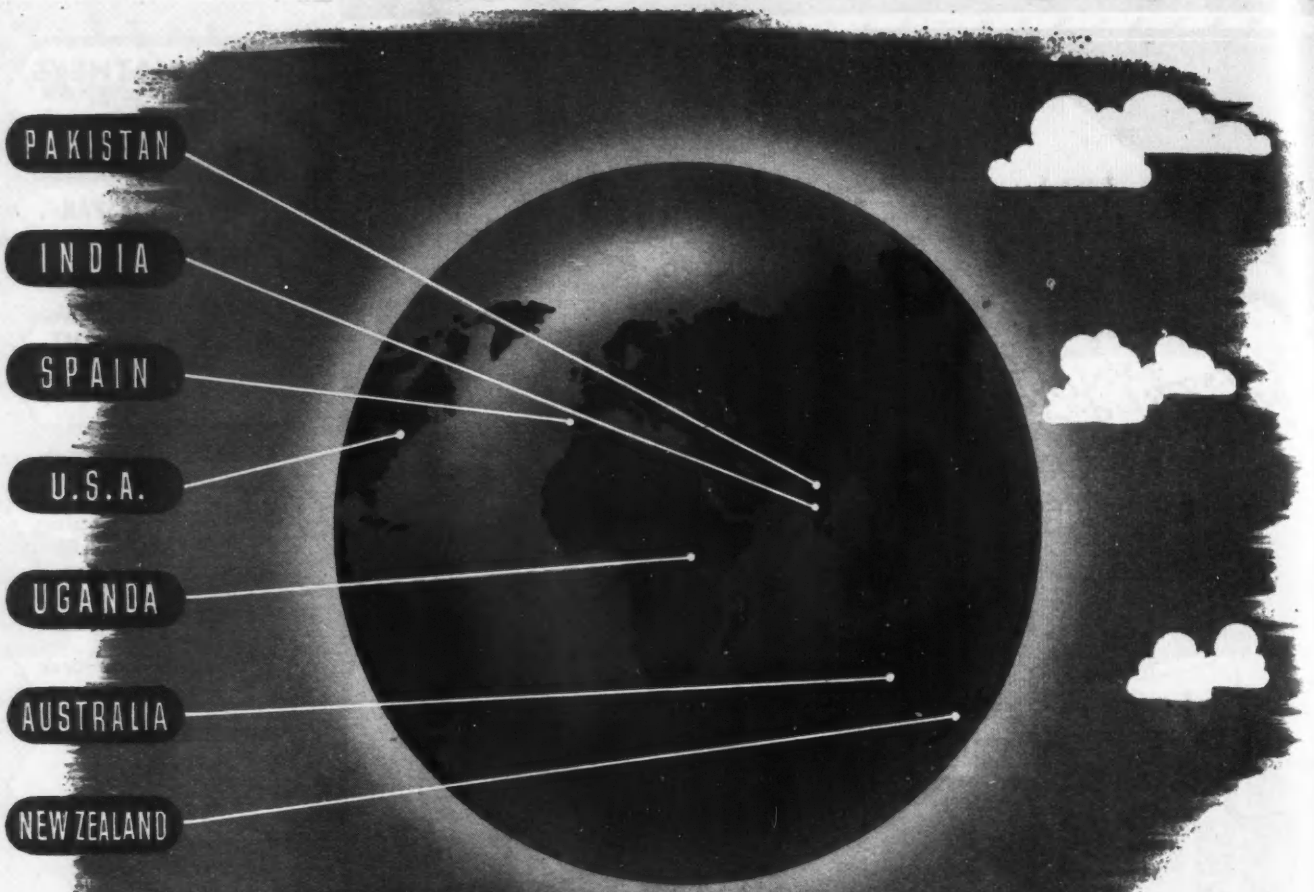

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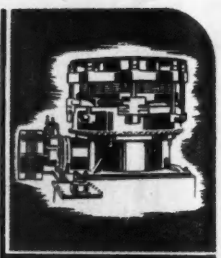

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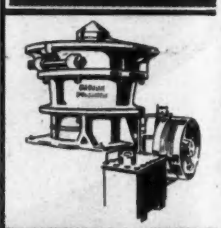

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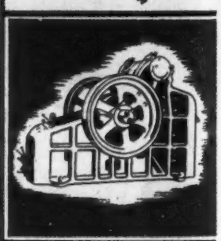

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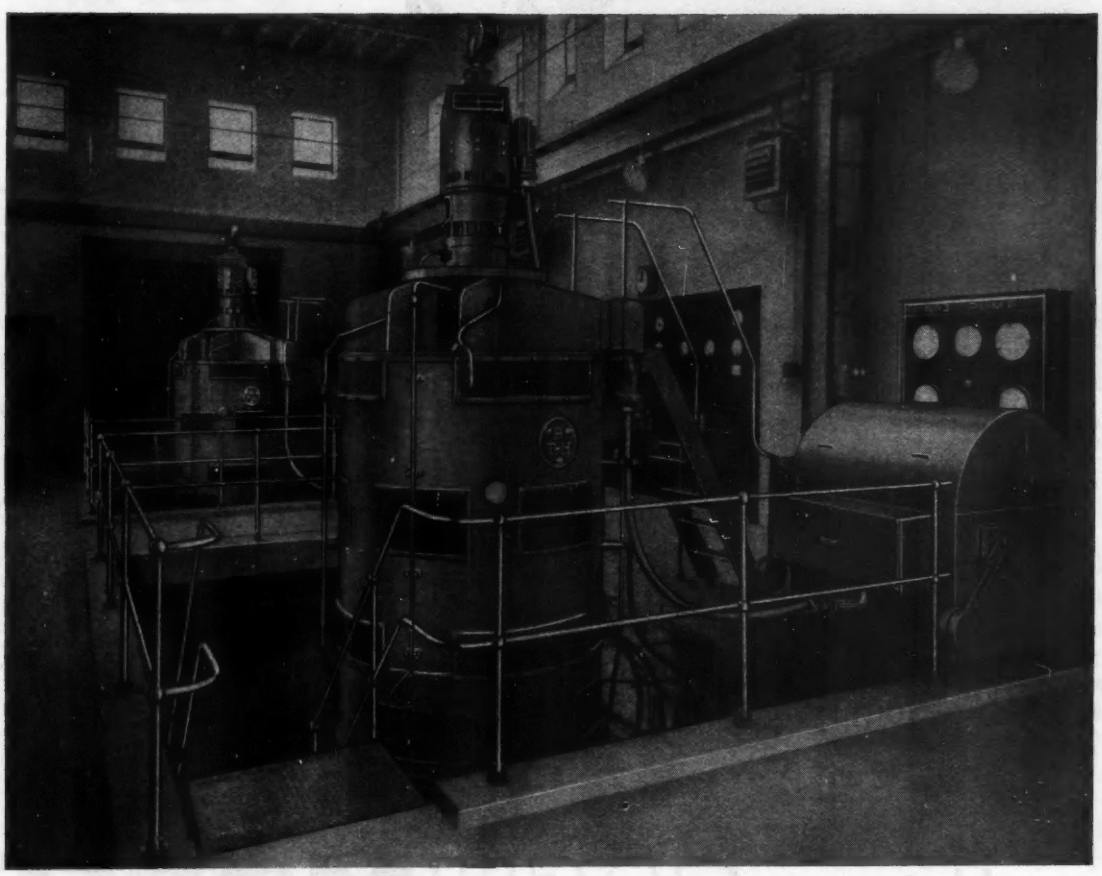

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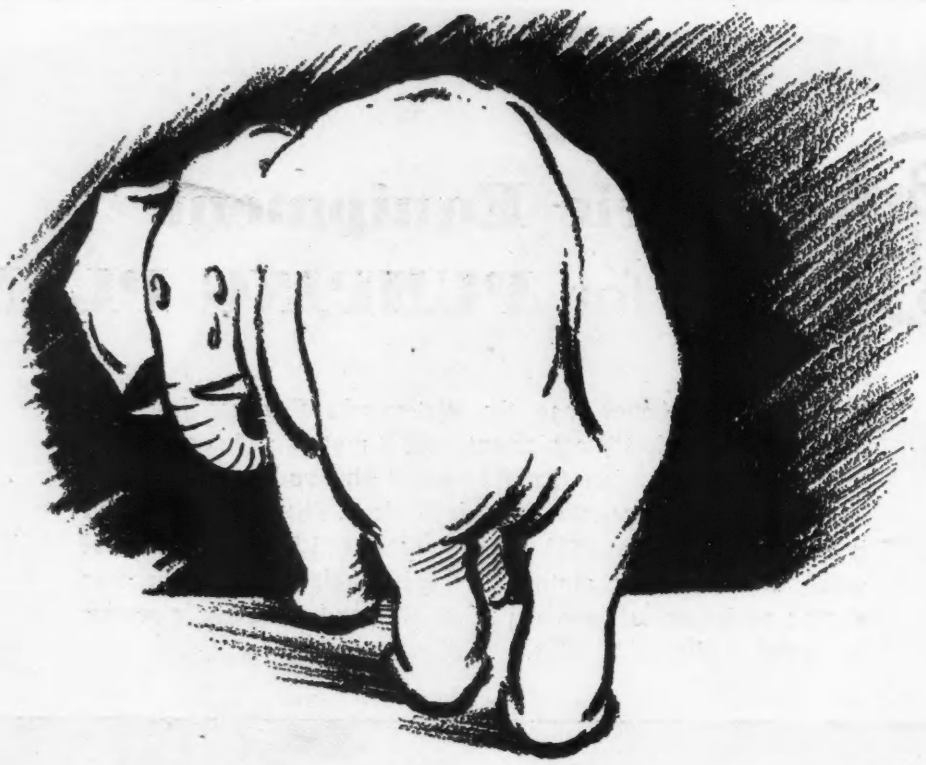

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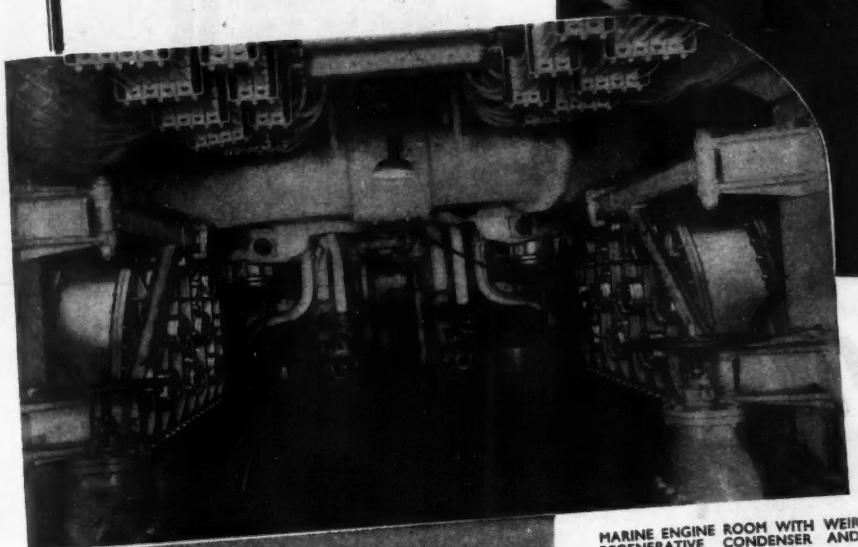

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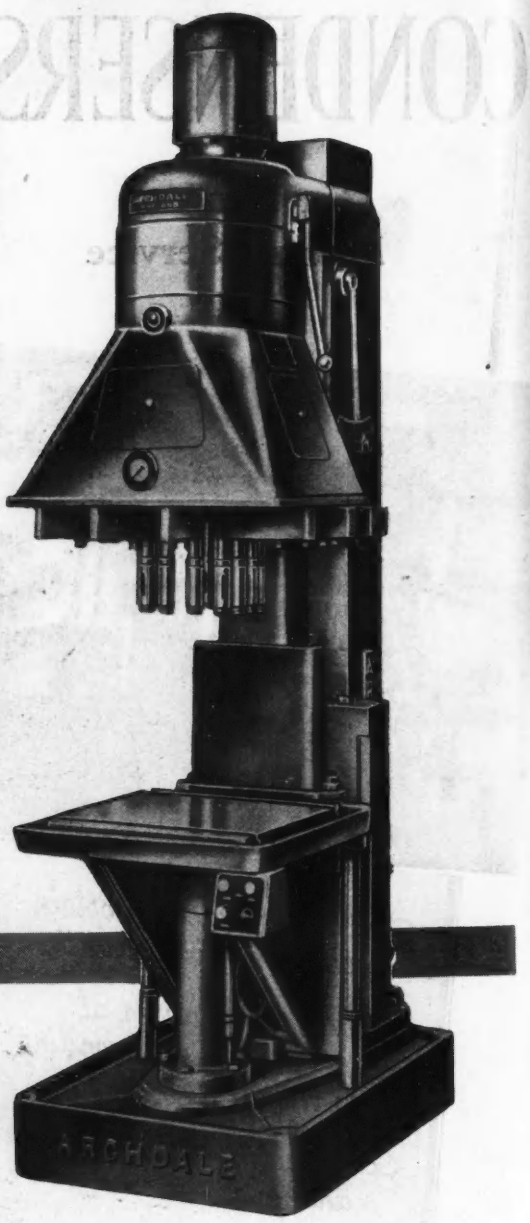

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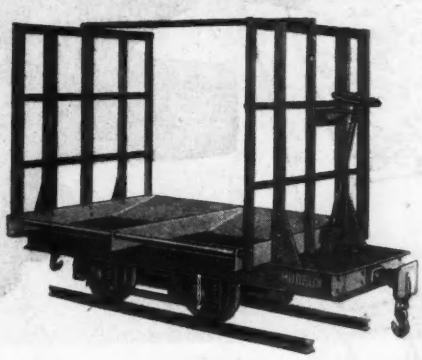

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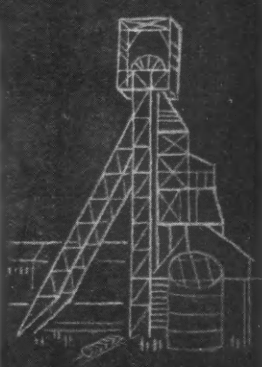

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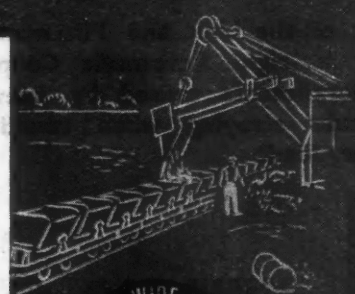

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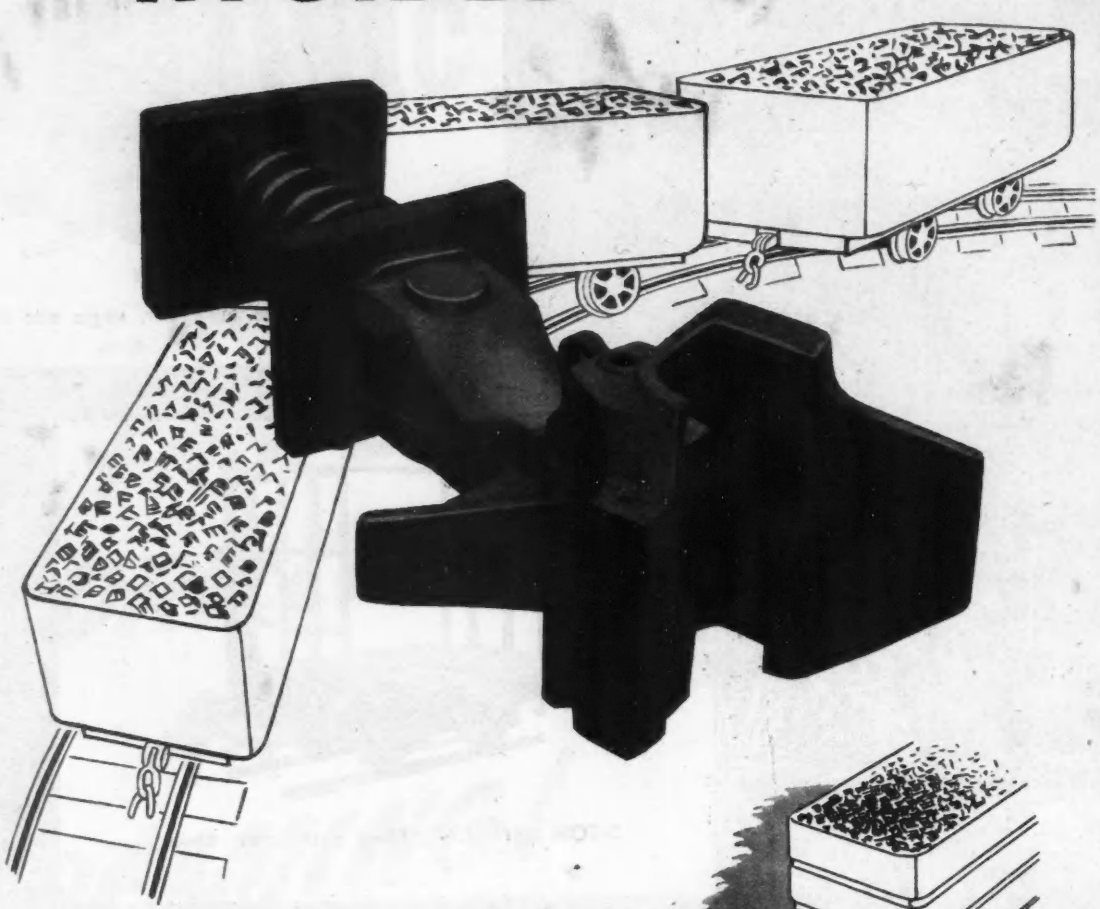

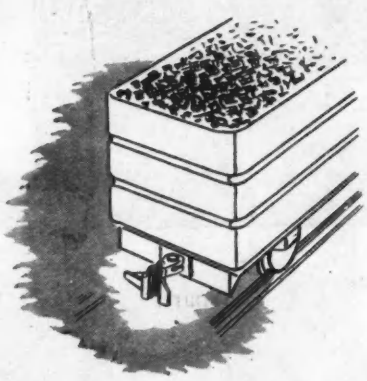

Replacement of the Link and Pin manual coupling by a rigid Automatic Coupler minimises derailments caused by uneven track, or tubs straying when rounding curves under load.

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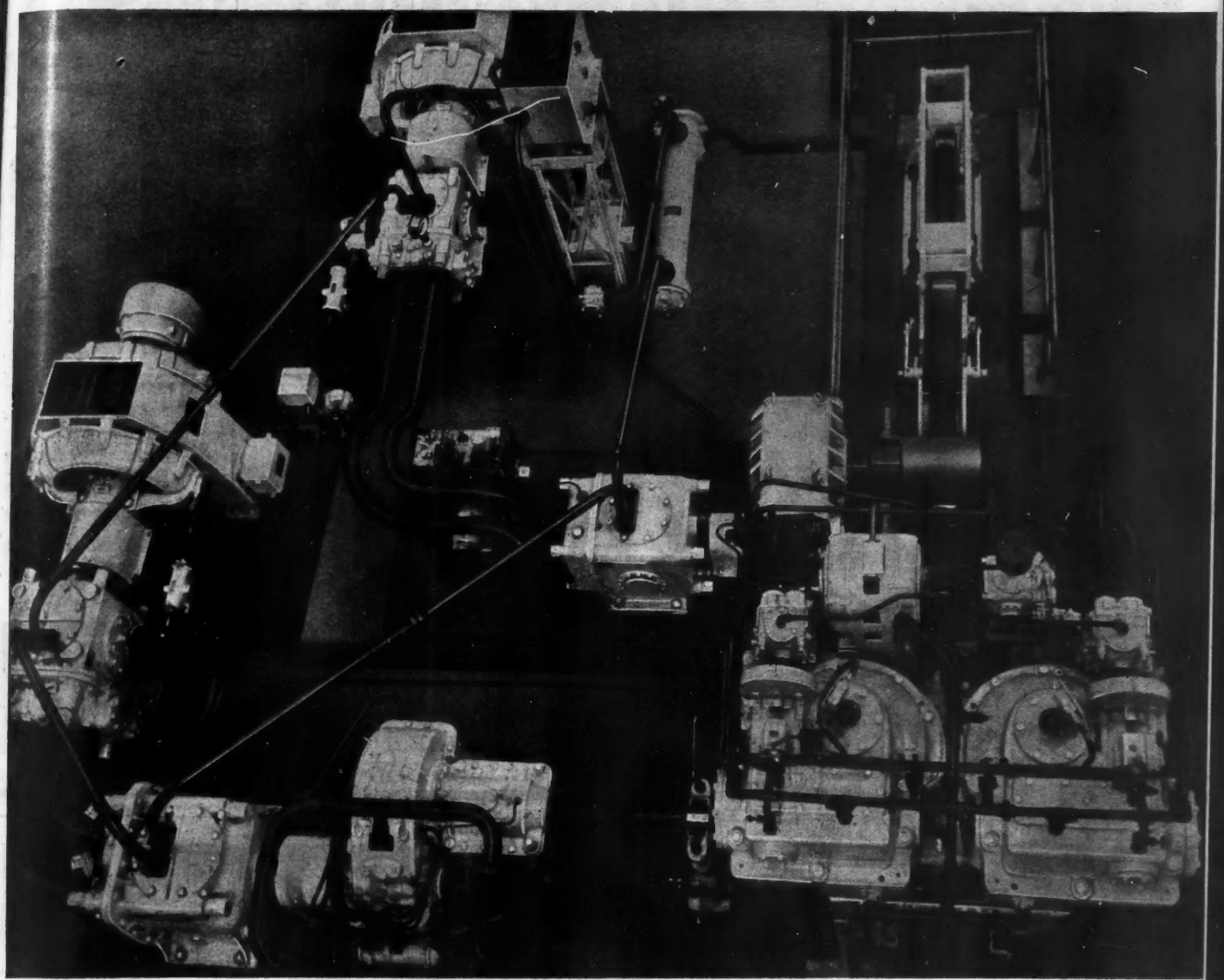

'VSG' units driving a Davy & United strip rolling mill in the non-ferrou department at Vickers-Armstrongs, Elswick.

Elswick Rolling Mill Re-equipped

With extended cold rolling capacity, the reconstructed Non-Ferrous Department at Vickers-Armstrongs, Elswick is now able to offer a much wider variety of brass and copper strip and sheet in greatly increased quantities. New mills and ancillary equipment of the latest designs, including Four-High Strip and Sheet Mills, driven by 'VSG' Hydraulic Units enable Vickers-Armstrongs to satisfy the demands of all strip and sheet users.

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In the cold strip mill, two separate 'VSG' pumps, each connected to a hydraulic motor, are used to control, from one point, the overall speed of the mill and of the coiler, and to maintain automatically the pre-set tension in the strip. 'VSG' units are also applied to the screw-down mechanism, one pump driving two hydraulic motors in series, with provision for running either or both motors as required.

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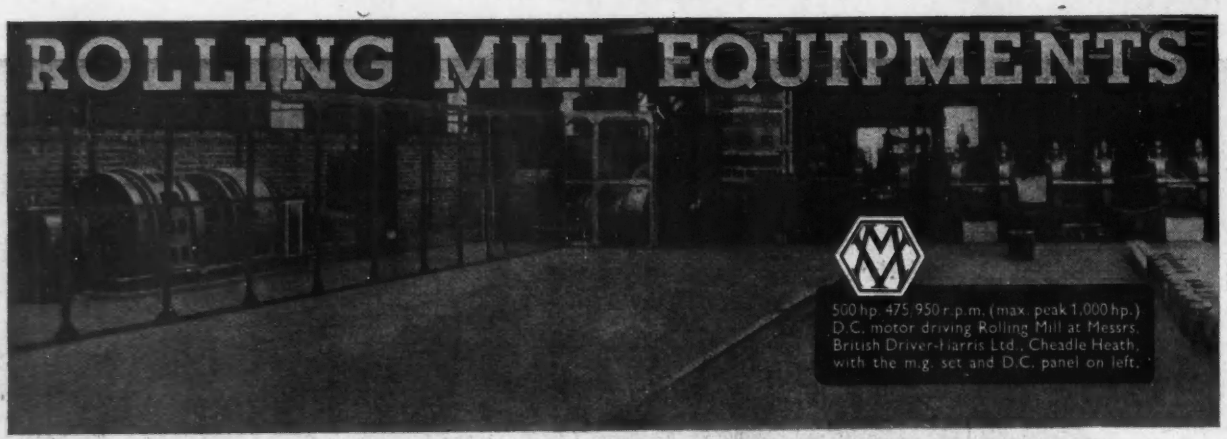

500 hp. 475/950 r.p.m. (max. peak 1,000 hp.) D.C. motor driving Rolling Mill at Messrs. British Driver-Harris Ltd., Cheadle Heath, with the m.g. set and D.C. panel on left.

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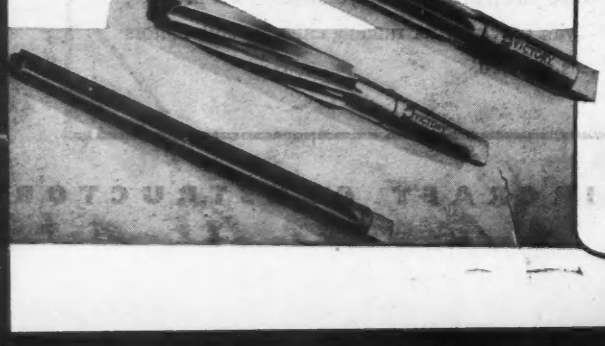

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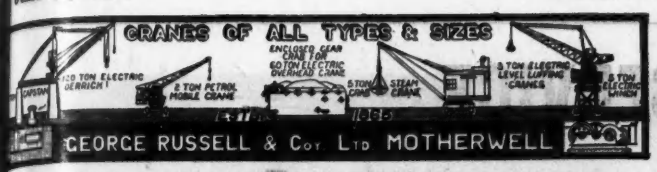

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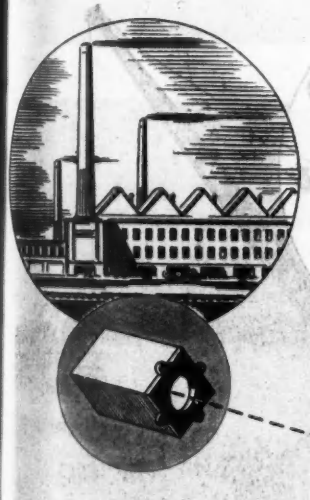

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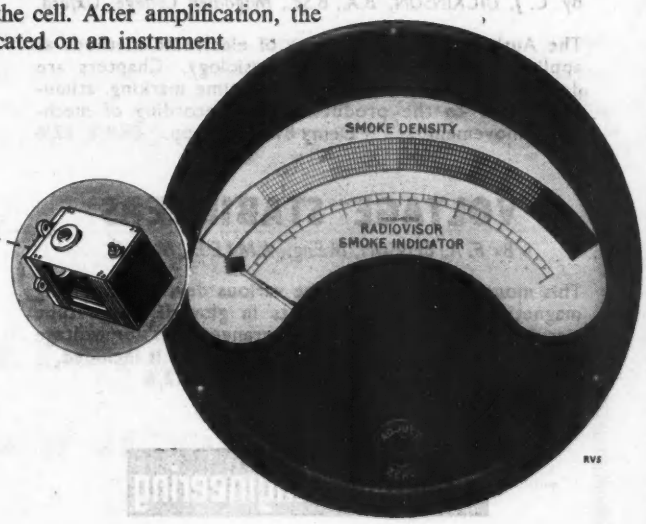

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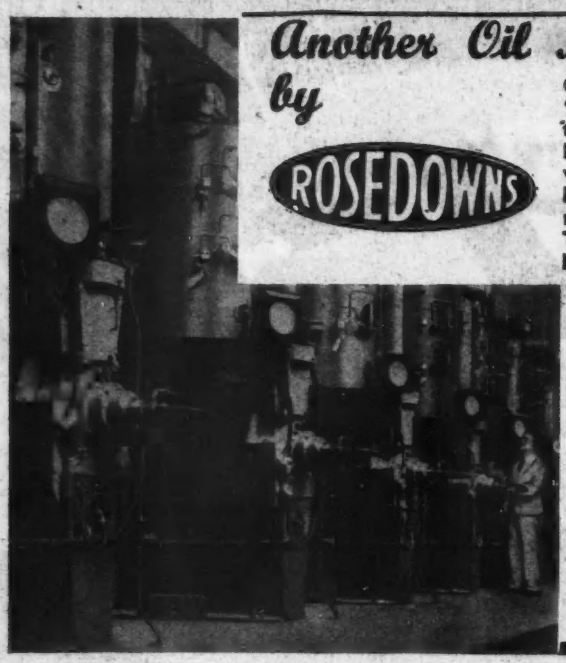

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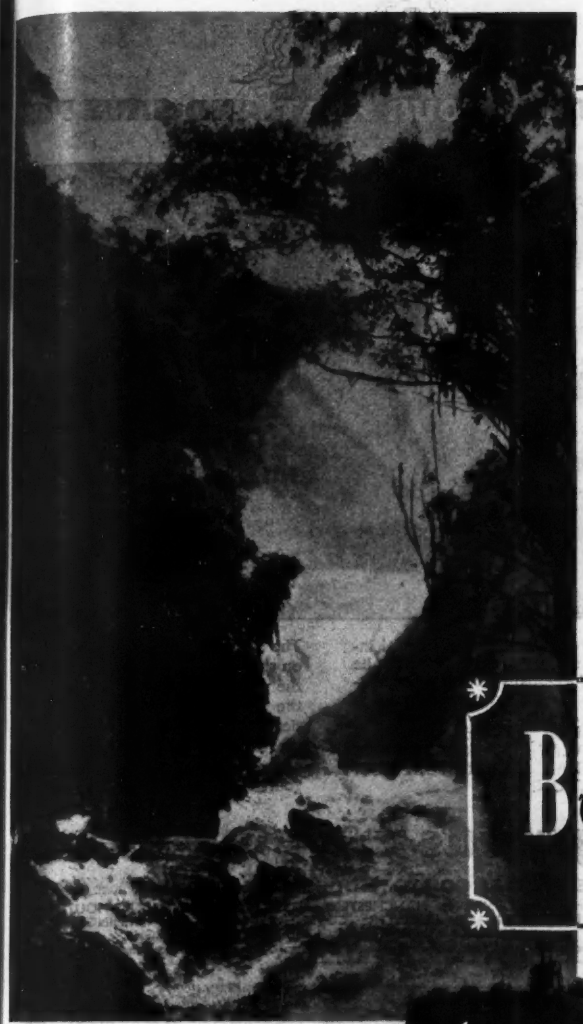

An impression of the Pangani Falls.

* * *

TANGANYIKA
The Pangani Scheme

The lower photograph shows two of the machines built by us. Three 3600 BHP and one 7200 BHP turbines are in service and a further 7200 BHP unit will shortly be installed. All are horizontal shaft Francis turbines, the larger sets being of the twin runner type. The whole of the design and construction of the Pangani Scheme was executed by Messrs. Balfour, Beatty & Company Limited.

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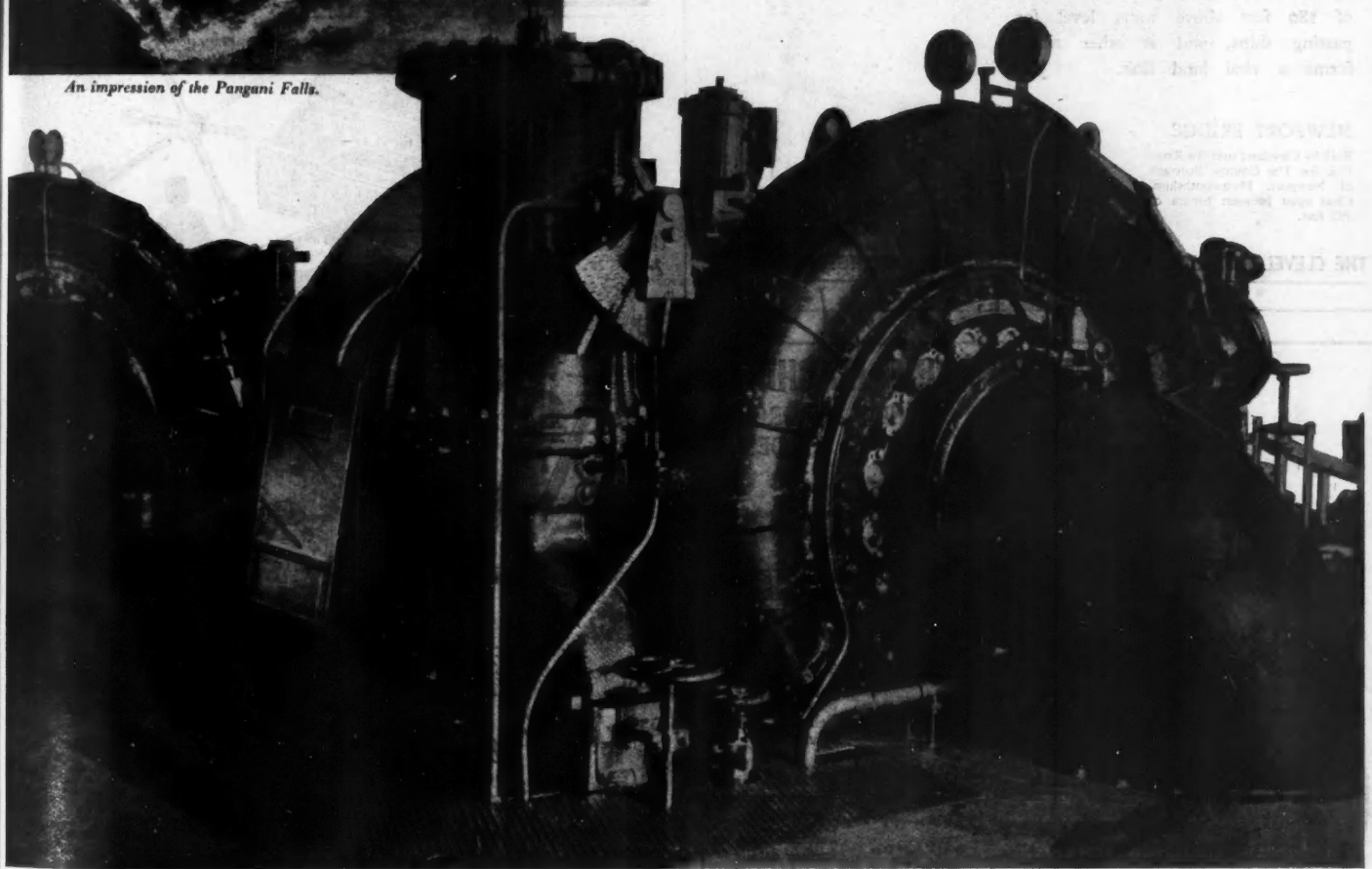

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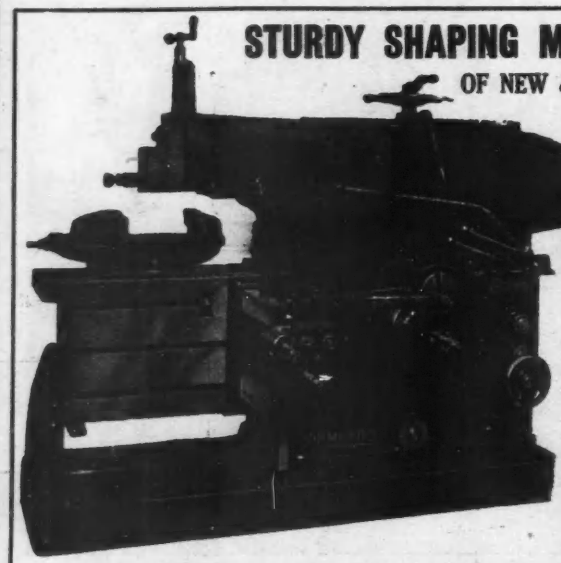

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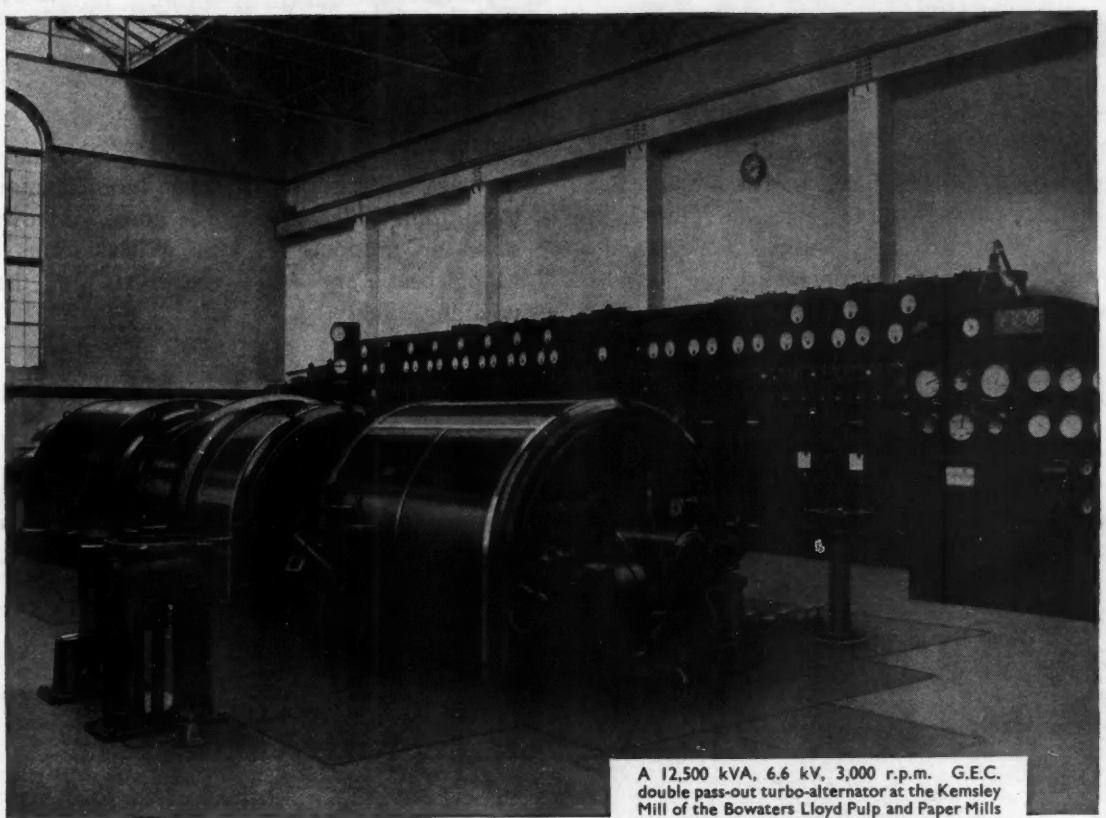

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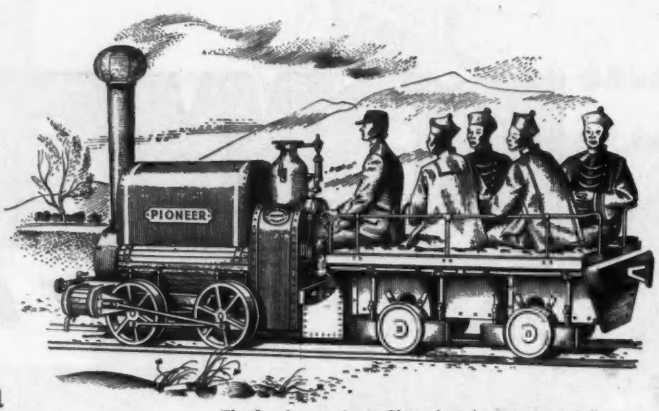

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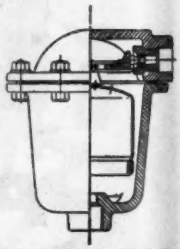

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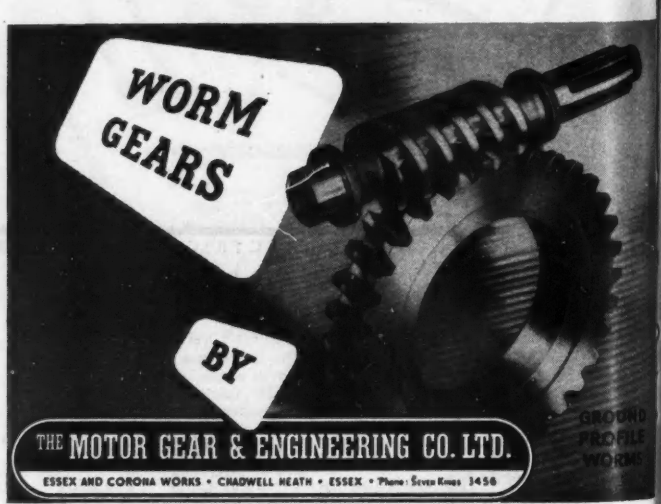
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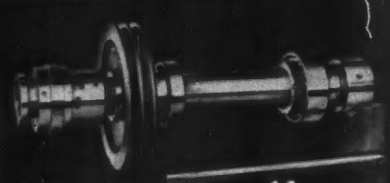

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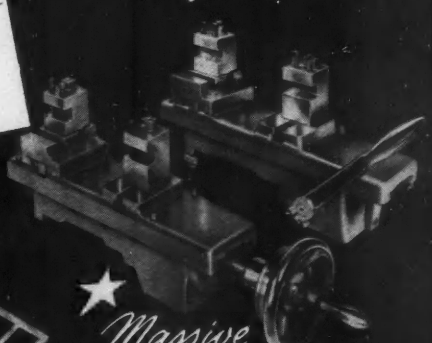

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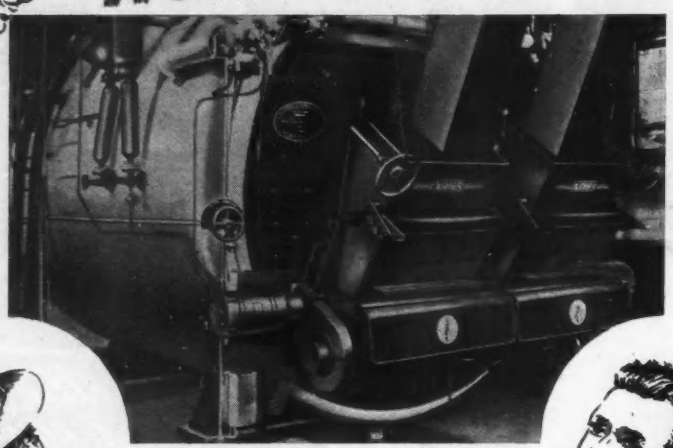

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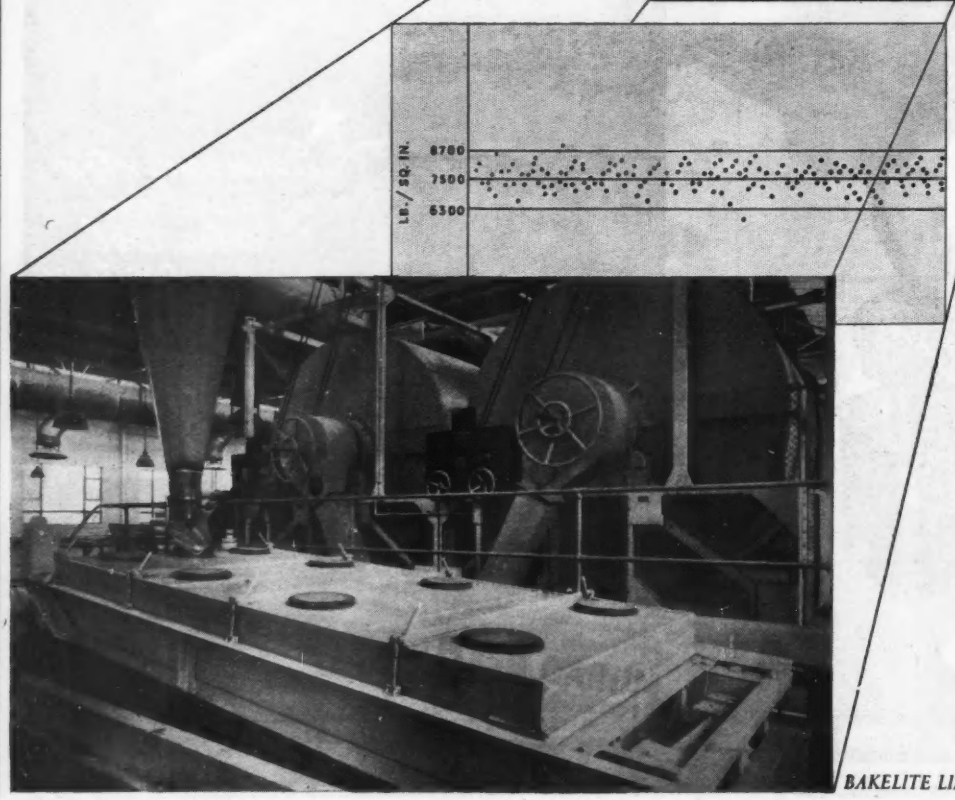

In the currency of words 'quality' has suffered serious devaluation. To have the same meaning to customer and manufacturer, quality must be measured by standards accepted by both. In the factories of Bakelite Limited, statistical quality control is a scientific process, in which the results of many tests are plotted and mathematically analysed to provide a 'case history' of each material. In the plastics industry this type of quality control was pioneered by Bakelite Limited. Statistical control enables quality to be assessed by using a very large number of results of routine tests carried out during manufacture, and the picture it gives is more comprehensive than any other. This provides one of the more obvious reasons for the reliability of BAKELITE moulding materials.

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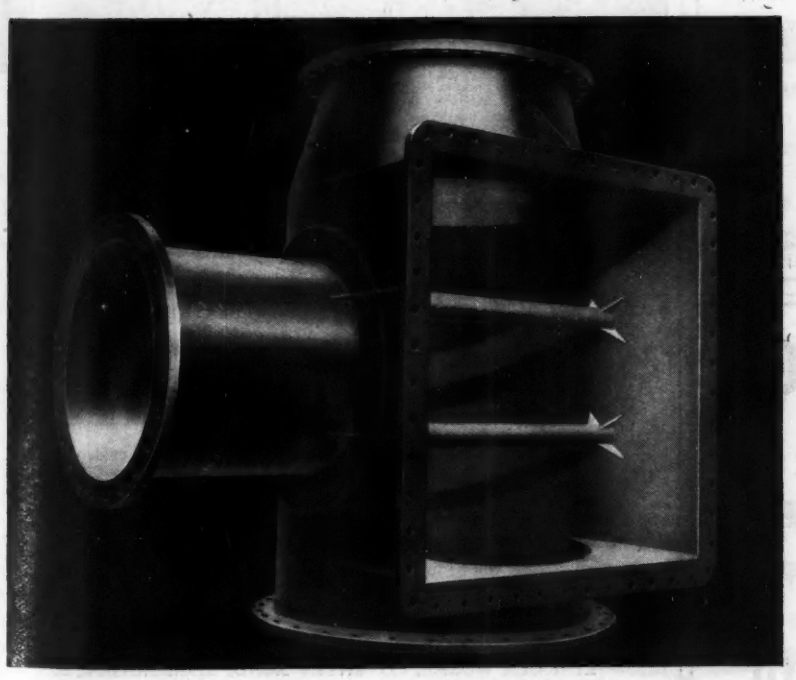

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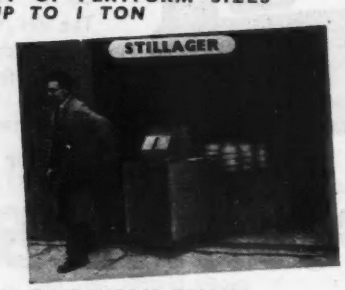

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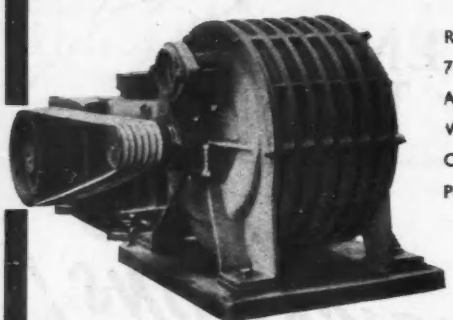

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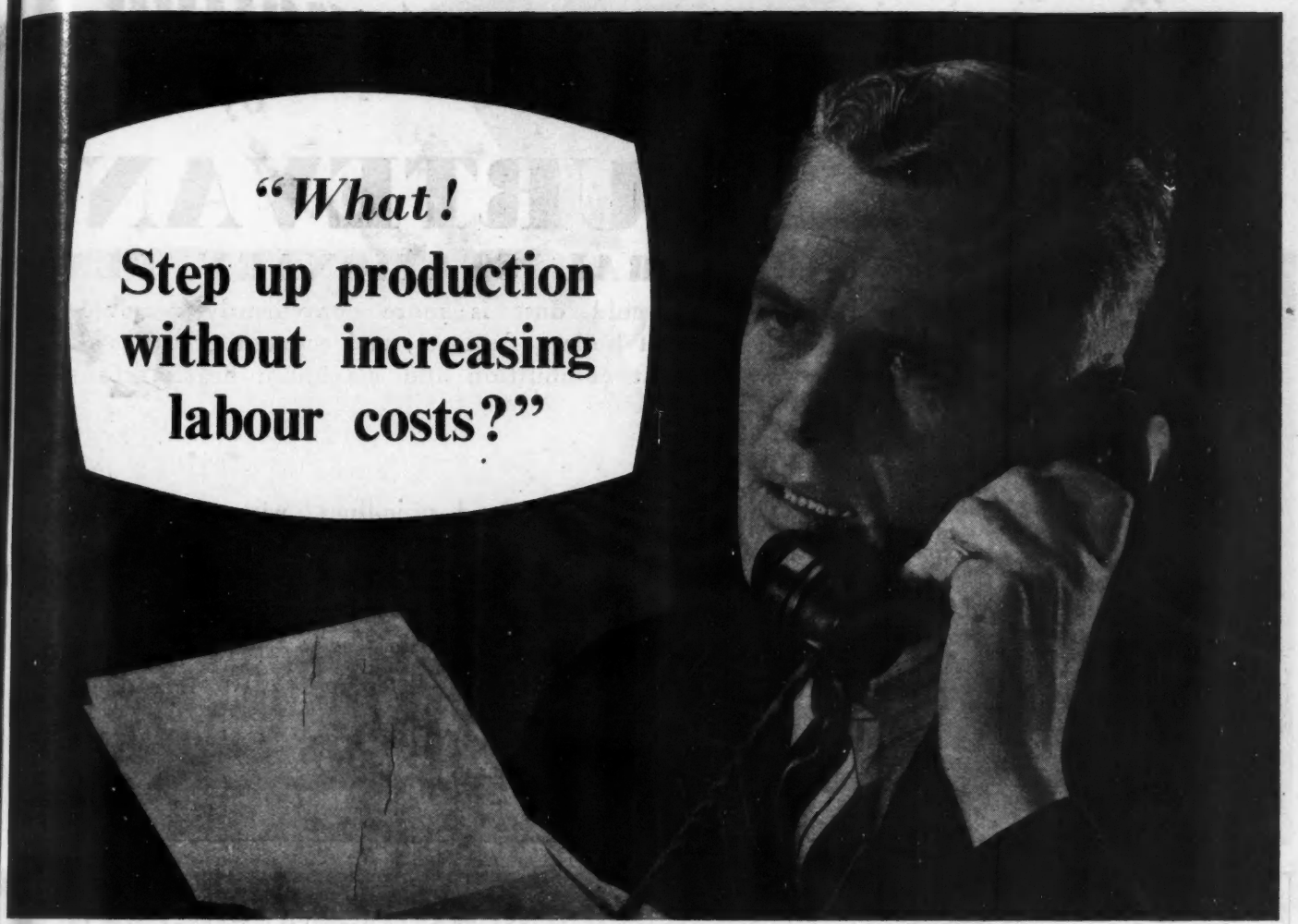

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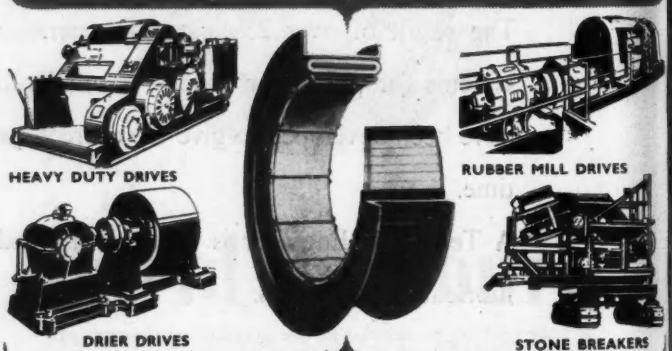

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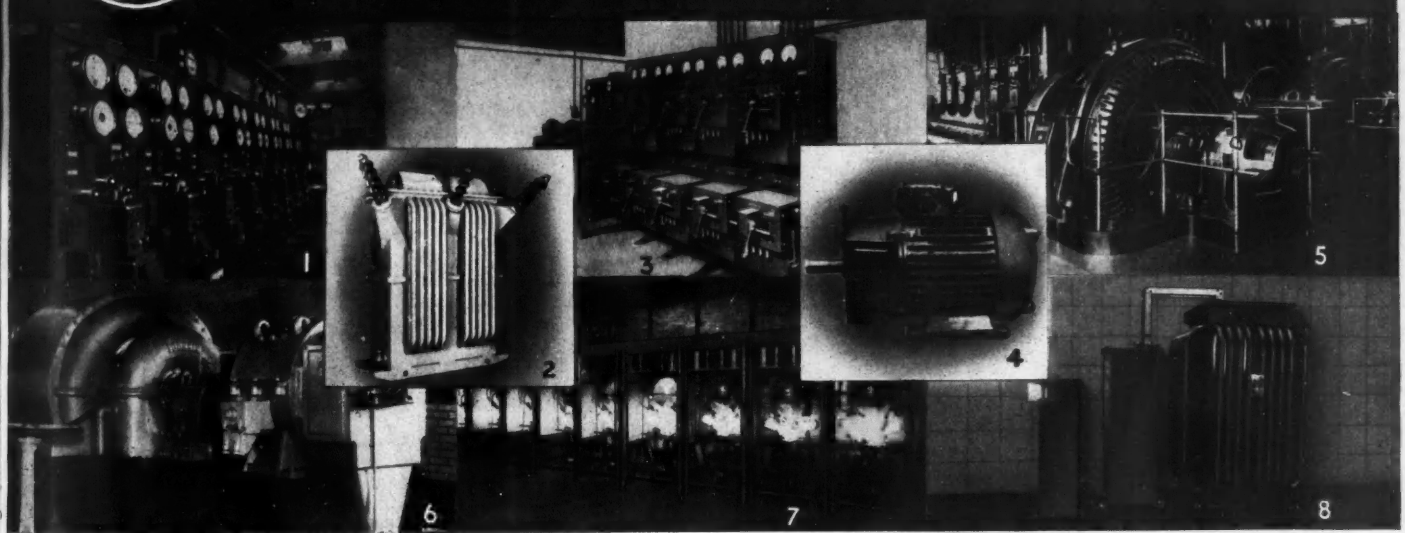

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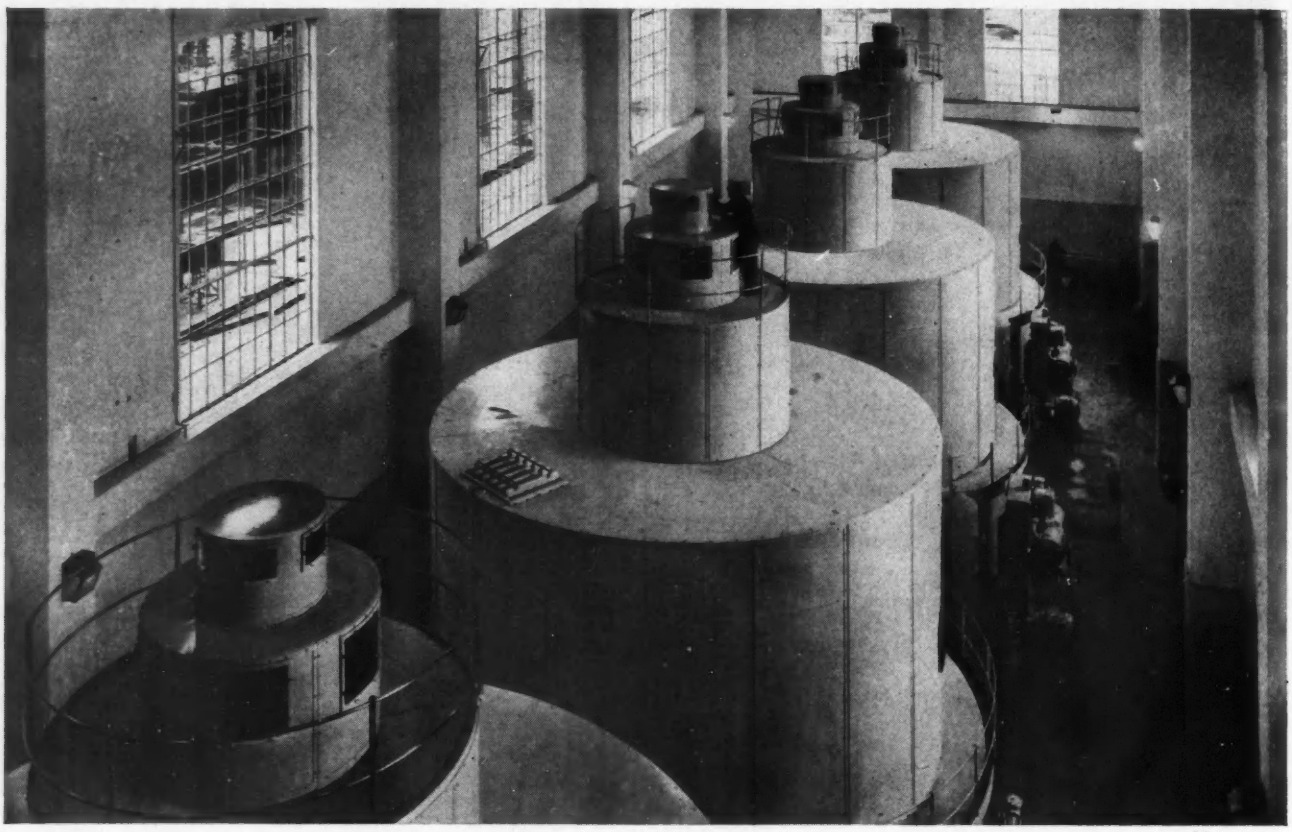

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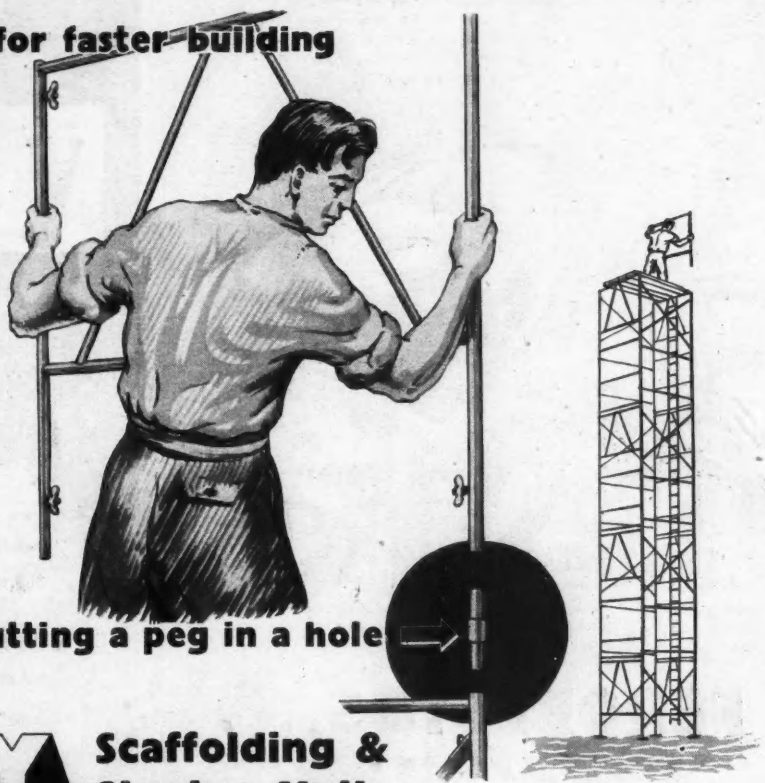

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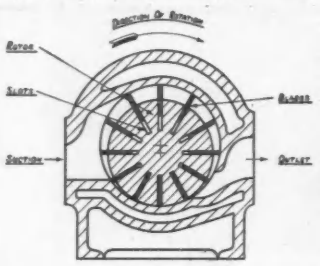
So important are the advantages of Ferobestos construction in suitable cases that a test may repay its cost many times. If you can give us details of the conditions under which your present components are working — dimensions, load, speed, temperature, nature of liquid, present lubrication method, etc. — we shall be glad to advise you.

In any case we shall be pleased to send you further information on this versatile material, which may suggest uses to you. Our experience, constantly being extended, is at your service.



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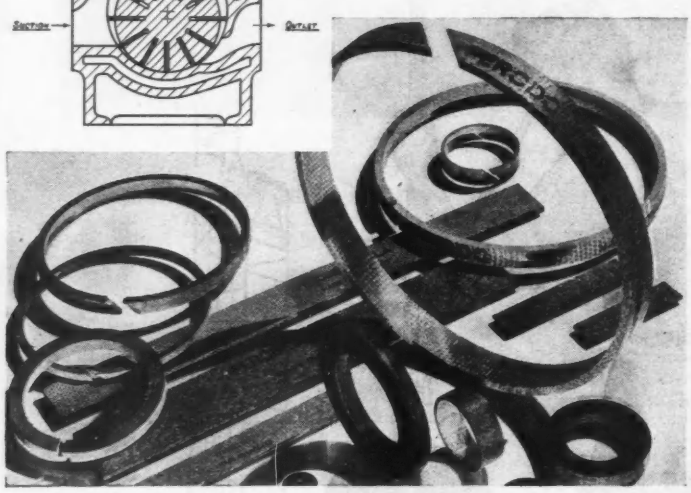

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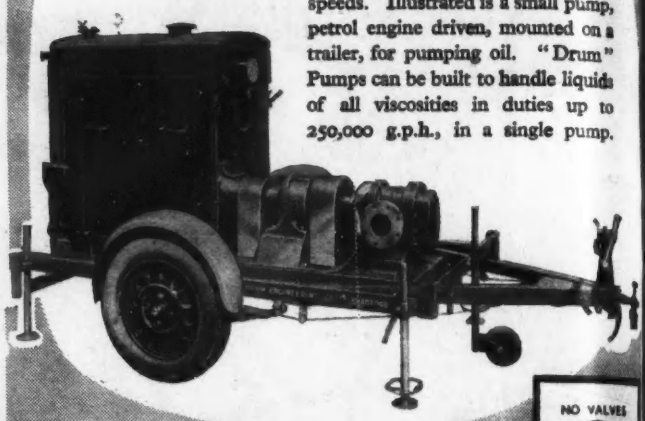

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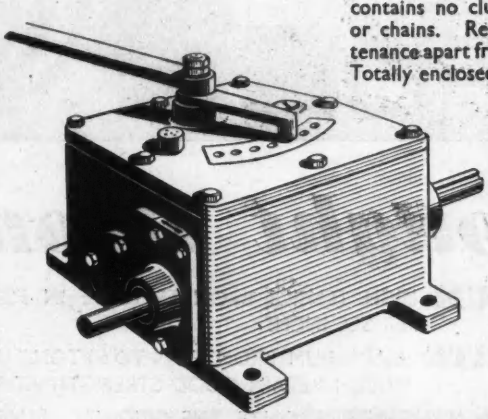

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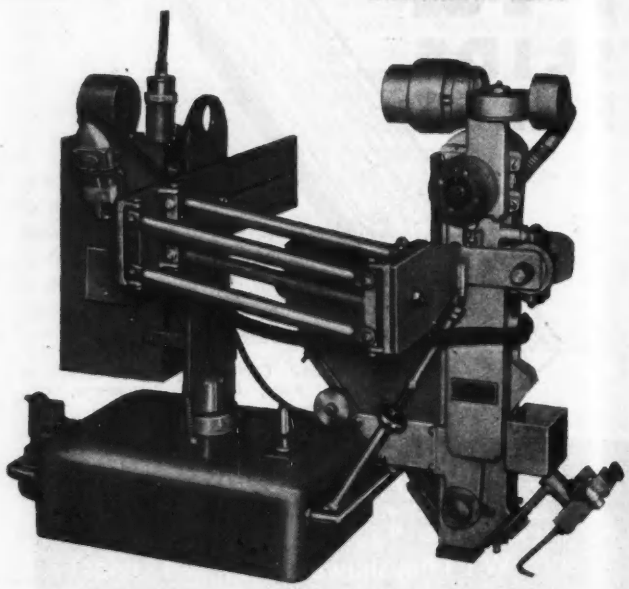

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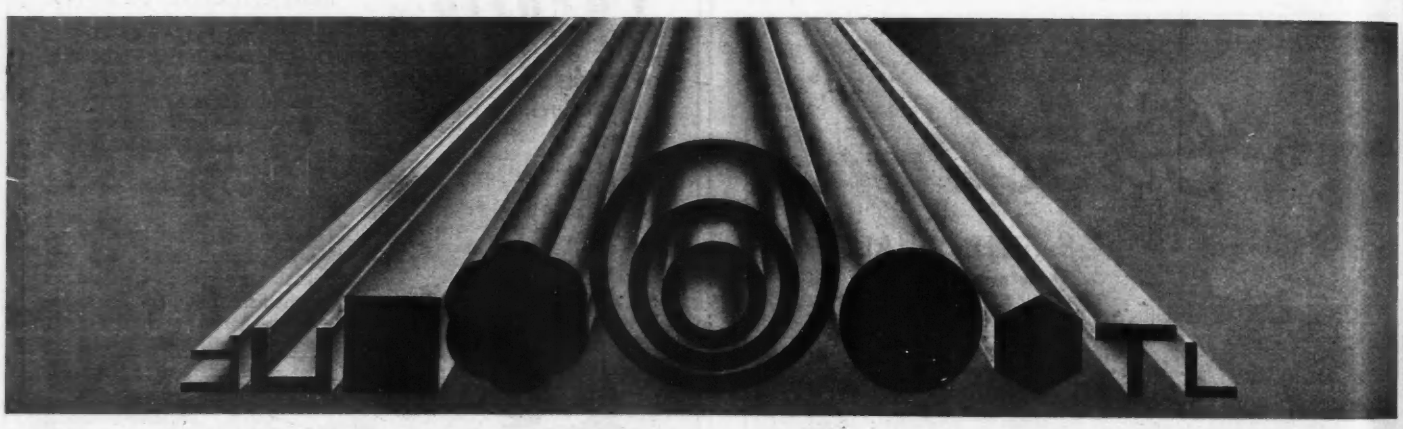

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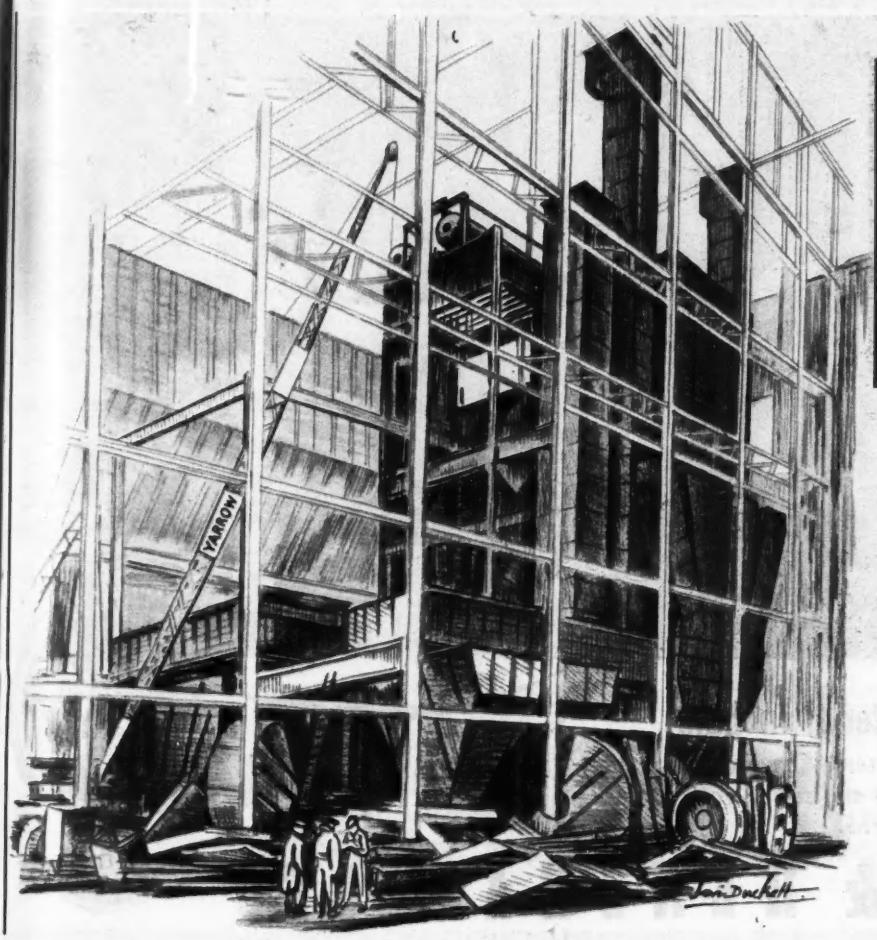

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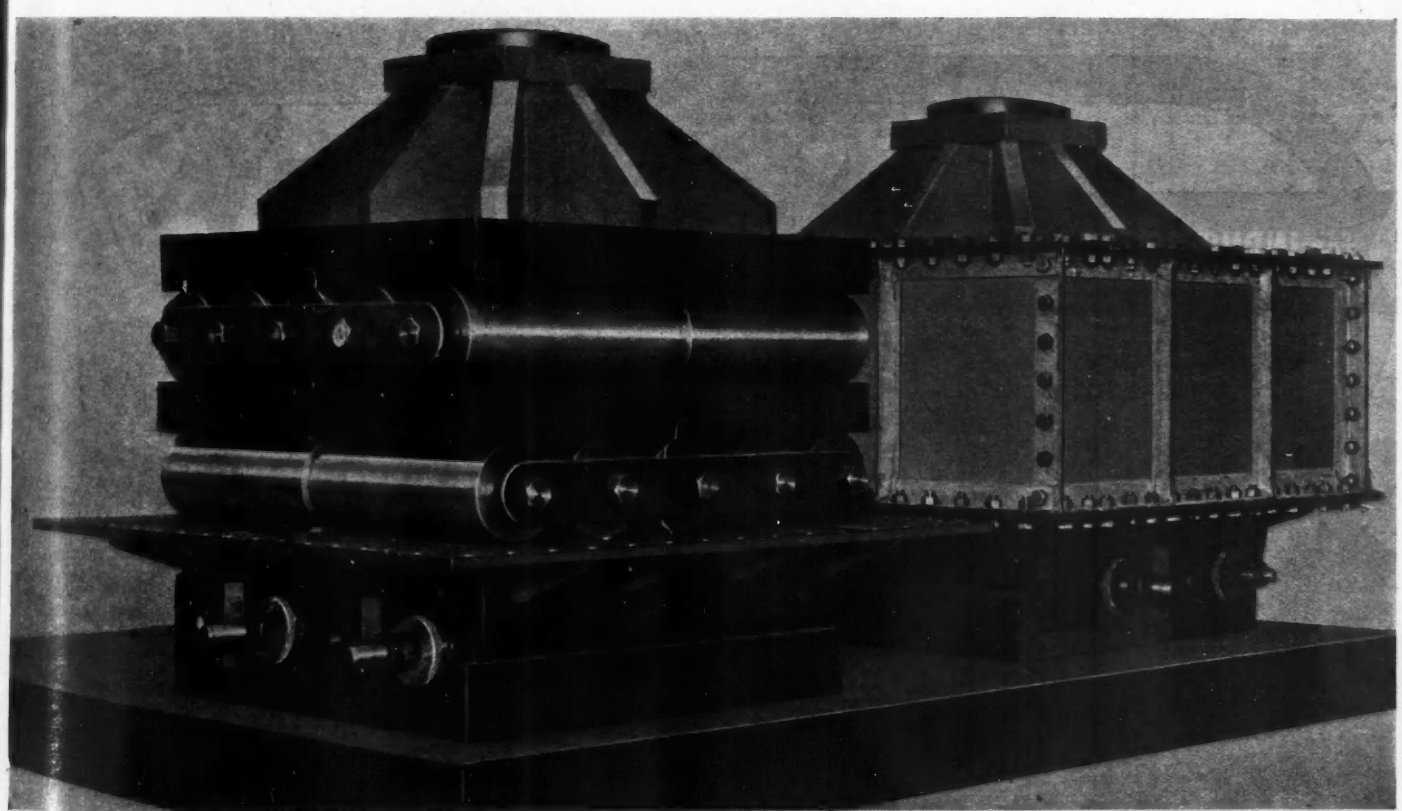

Universal Bearings to support 250 tons, allowing for horizontal movement in all directions, and also vertical adjustment. The illustration shows two Bearings, one with grease casings removed.

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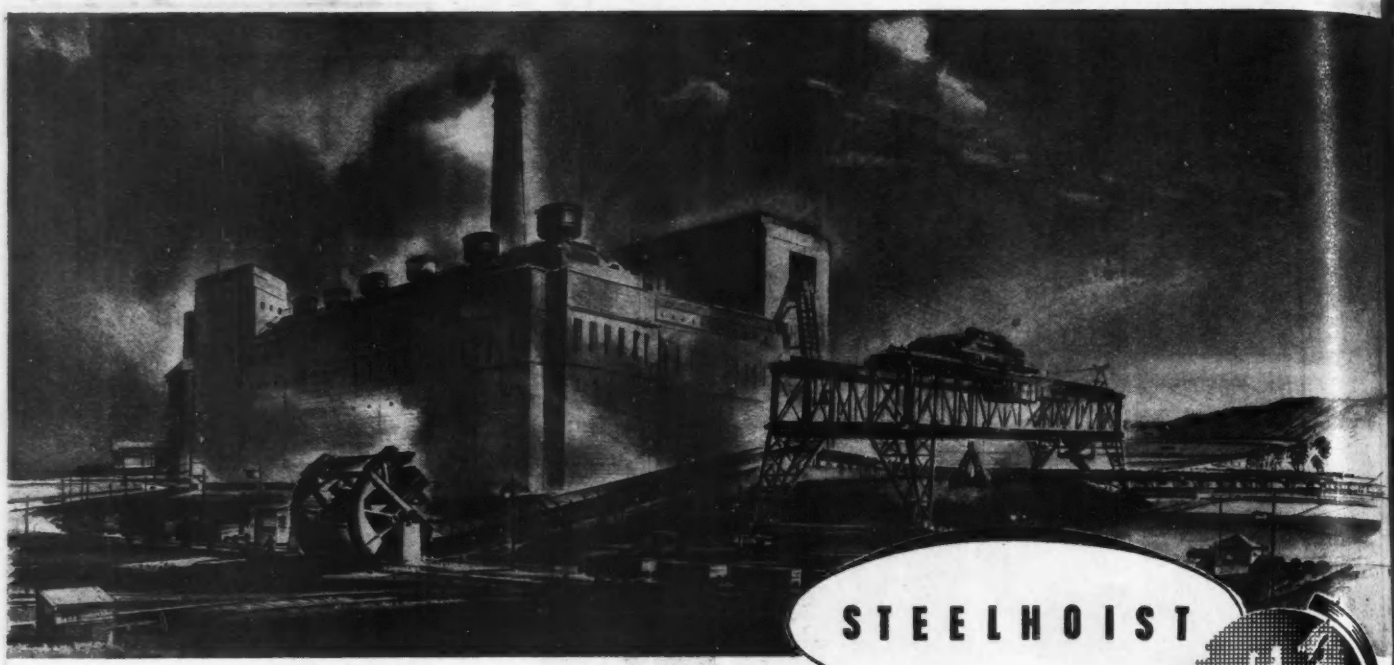

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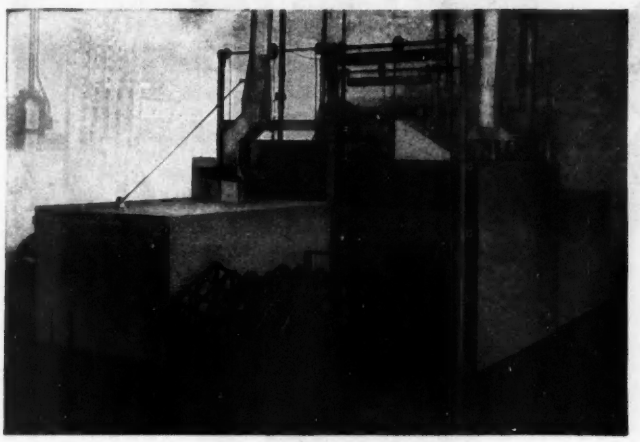

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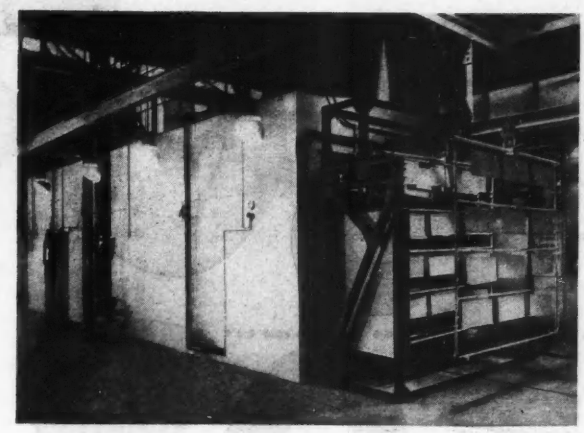

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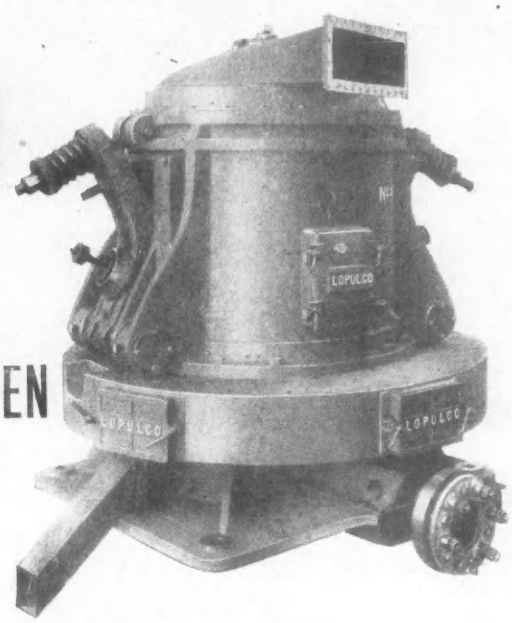
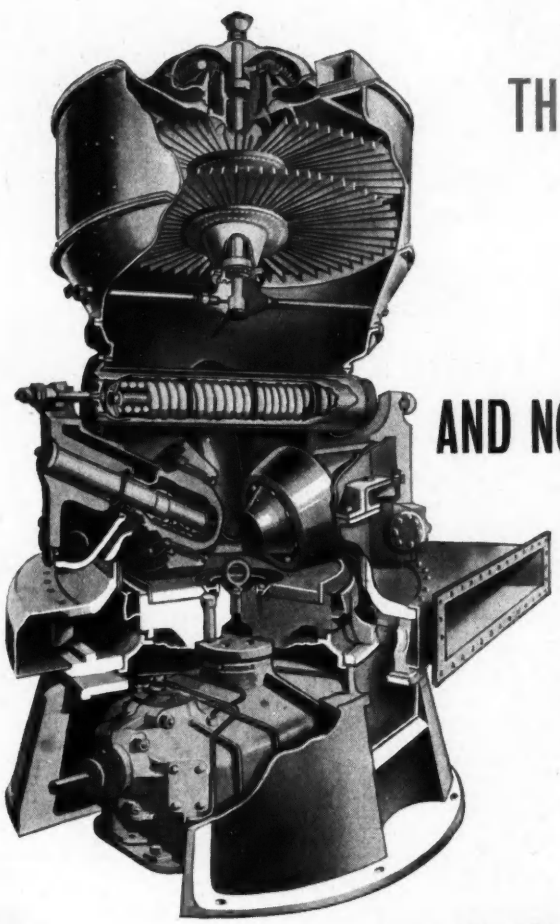
PROGRESS...

the Lopulco Mill



THEN



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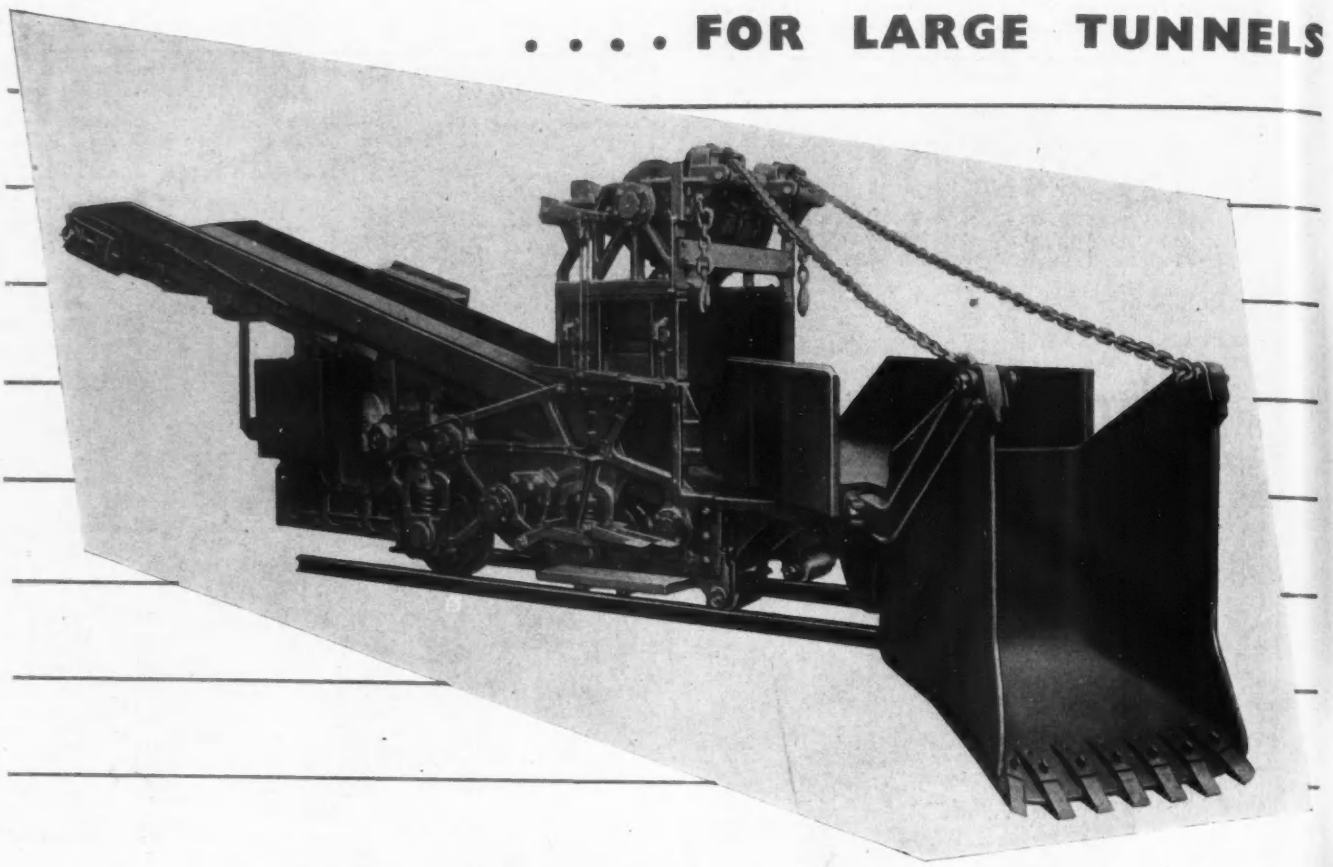

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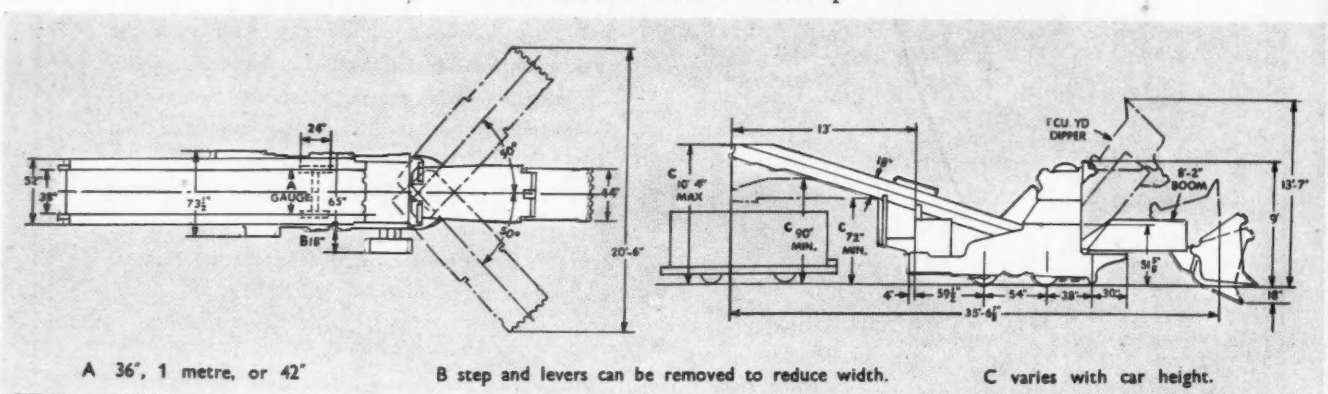
FOR TUNNELS UP TO 18ft. x 30ft. Simple control by means of two hand levers and two foot levers. A separate motor drives the discharge conveyor. The maximum clean-up width of a standard machine is 20ft. 6in., and similar machines can be built with other maximum widths of clean-up.



A 36", 1 metre, or 42" B step and levers can be removed to reduce width. C varies with car height.

MOTOR H.P.	WEIGHT (TONS)	DIPPER CAPACITY	LOADING CAPACITY CU. FT. PER MIN.	LOADING CYCLES PER MIN.	TRAMMING SPEED ft. per min.	
					FORWARD	REVERSE
Main 100 Conveyor30	20	1 cu.yd.	162	6	180	123

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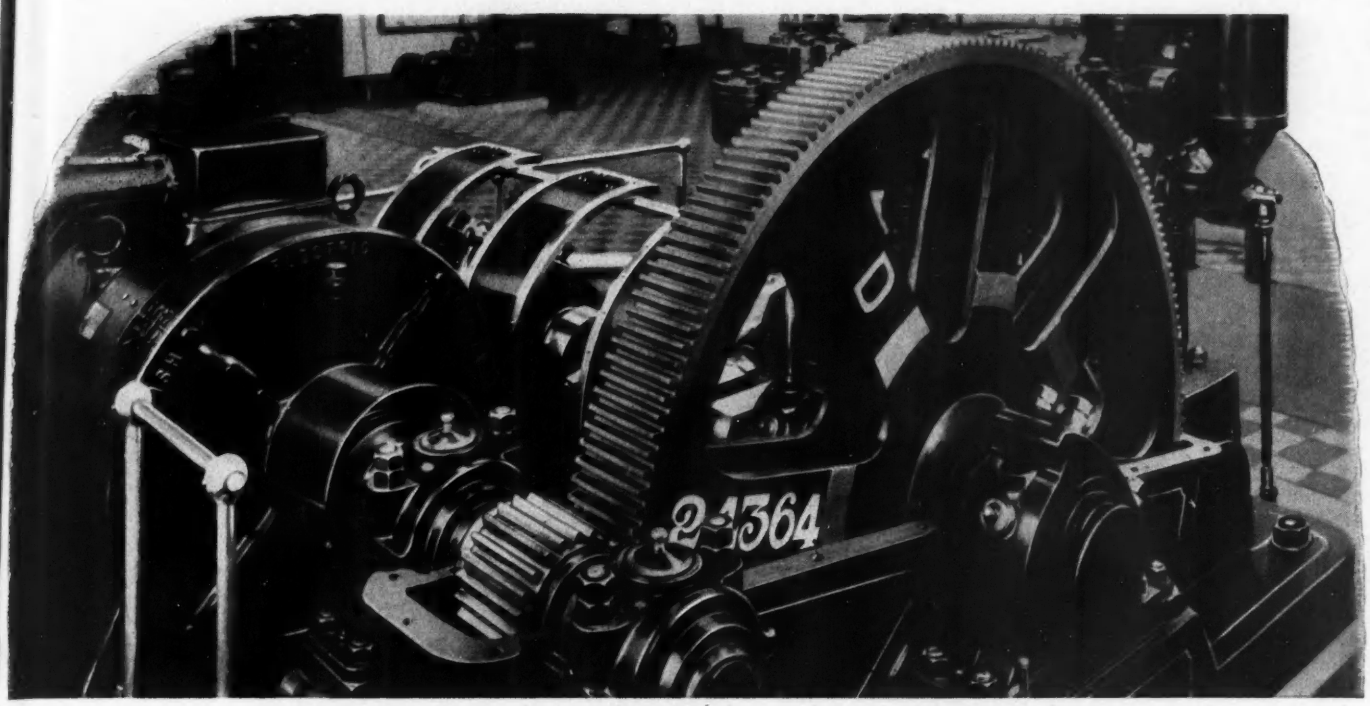

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the original tooth grinding marks are STILL VISIBLE

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These Angus Gears are driving a 120 H.P. Worthington-Simpson Pump at the Albert Edward Dock Pumping Station of the Tyne Improvement Commission. Four of these pumps were installed in 1928 and the gears show no signs of wear or deterioration after 22 years' completely trouble free service. The results illustrate the importance of

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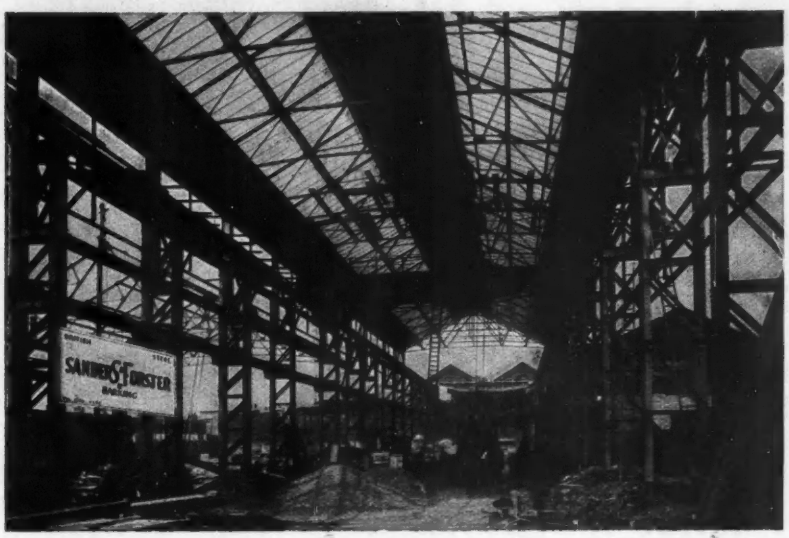

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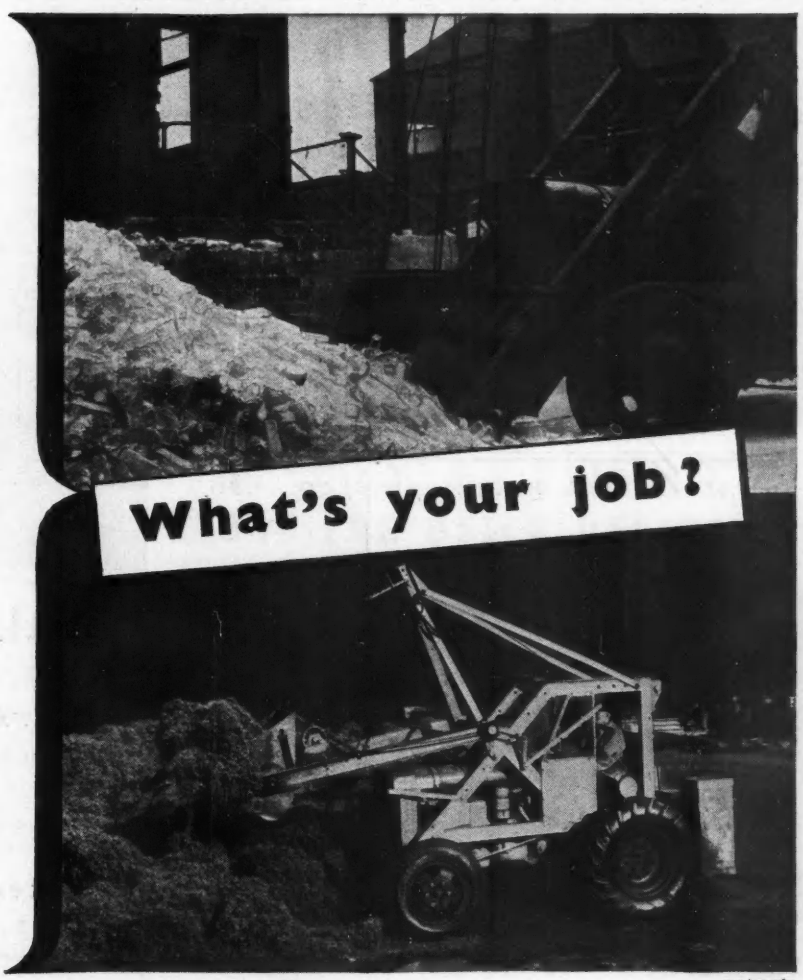

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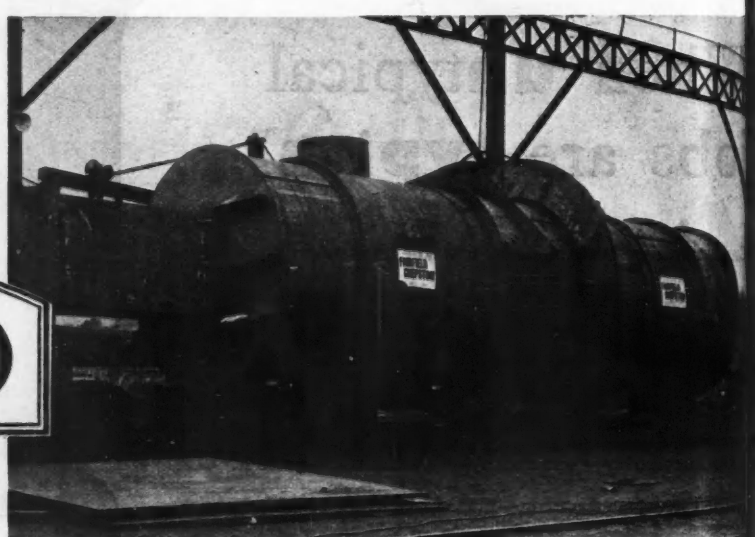

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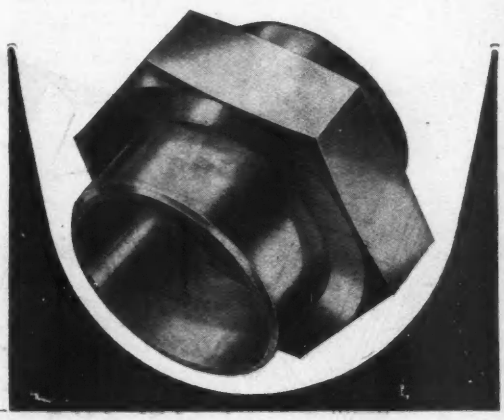

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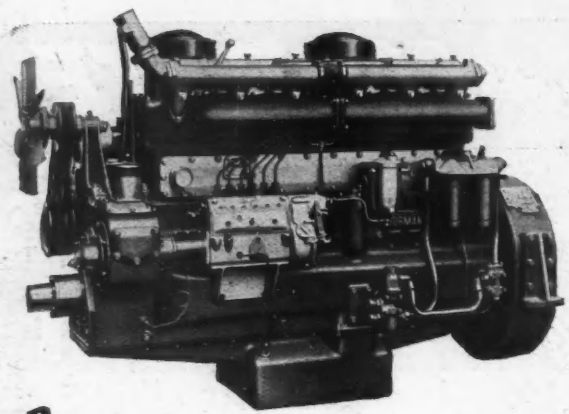

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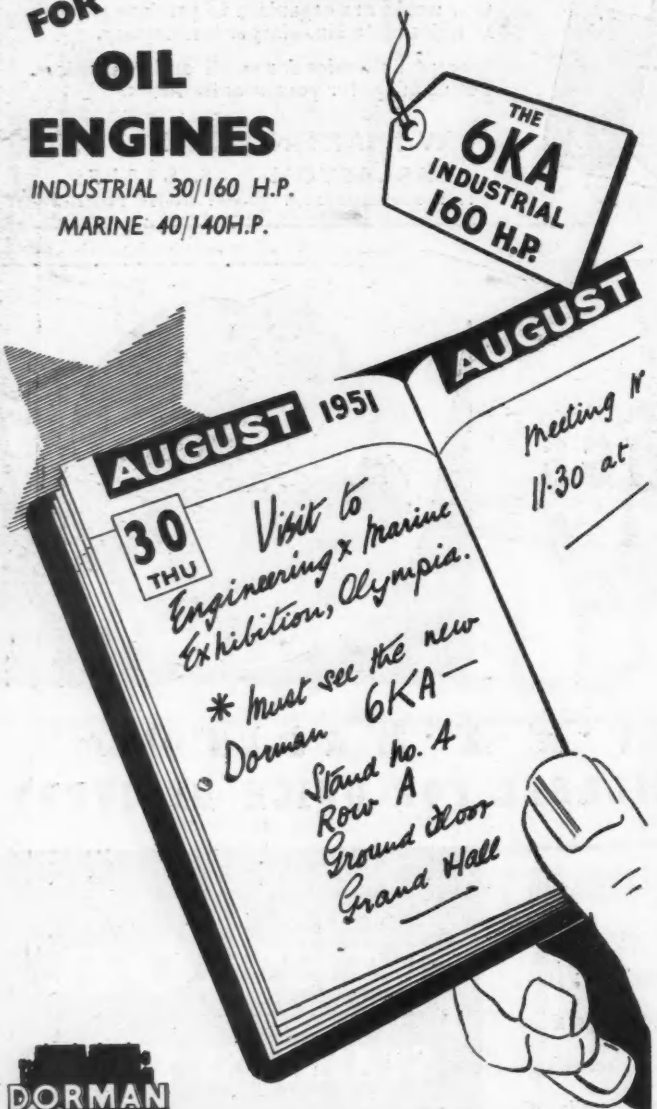

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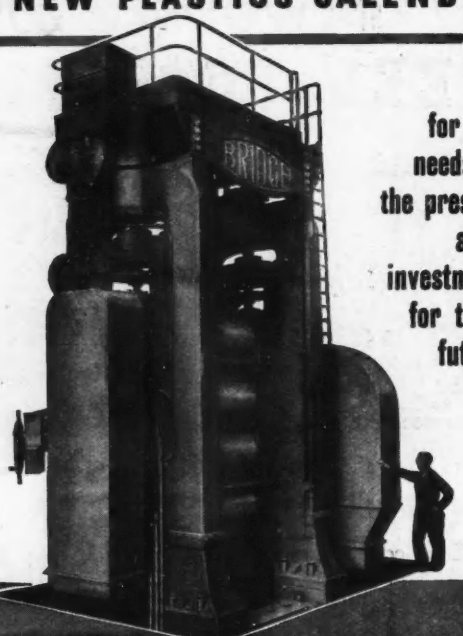

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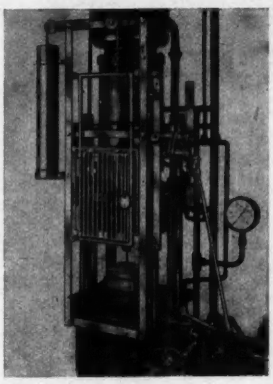

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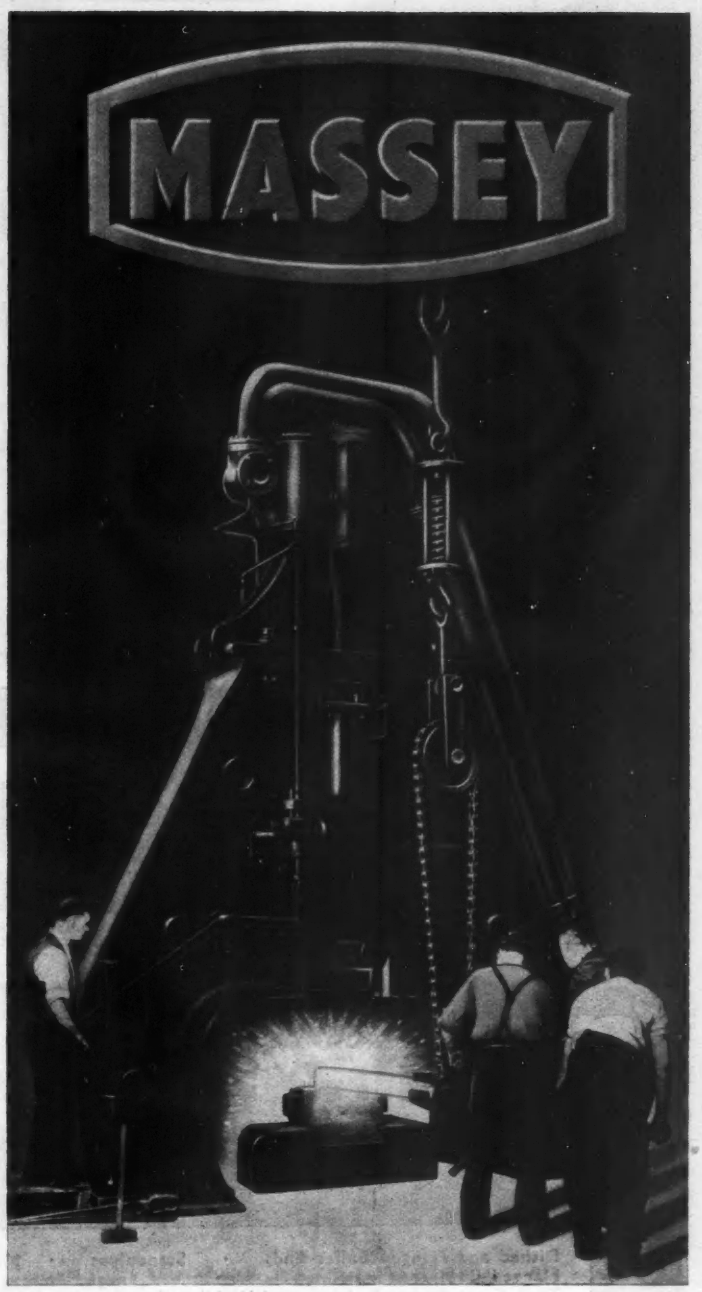

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Two-ton arch form Massey Steam hammer in the Openshaw Works of the English Steel Corporation Ltd., forging down special high-quality steels. Note the Massey Expansion Valve Gear on the left-hand standard which, by simple means, uses steam or air expansively and thereby greatly reduces consumption and running cost. Concurrently, it very notably improves control and increases safety.

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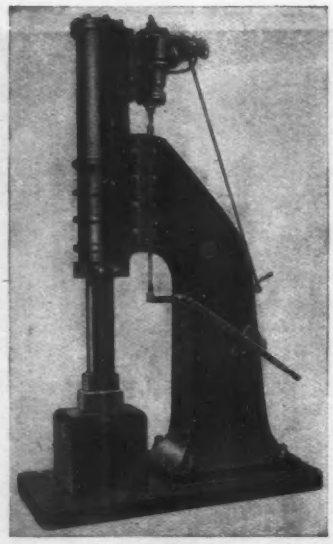

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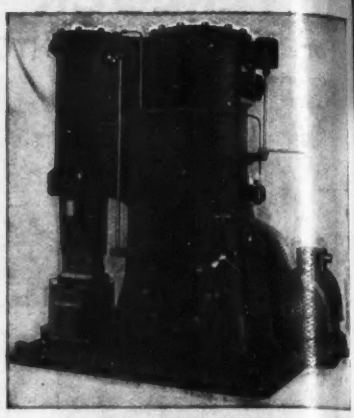

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Crane Gun Metal Globe Valve — renewable disc — union tailpiece. No. D225. Sizes: ¼", ⅜".

This newcomer to the Crane range can be fitted with a new disc in a couple of minutes — it's as simple as that! A renewable steam disc is rigidly held in a holder which swivels on the stem. Disc and holder are easily removed by unscrewing a bush. The Fig. D225 is particularly robust and suitable for use on steam radiators. Also recommended for other steam heated equipment — sterilizers, boiling pans, unit heaters, etc. The inlet and outlet connections are screwed British Standard Taper Pipe threads. Packing of generous length is compressed by a machined gland and packing nut. A composition or metal non-heat handwheel is fitted. Maximum steam working pressure is 125 pounds per square inch. This is just one item in a wide range of Crane Cast Iron and Gun Metal Valves.

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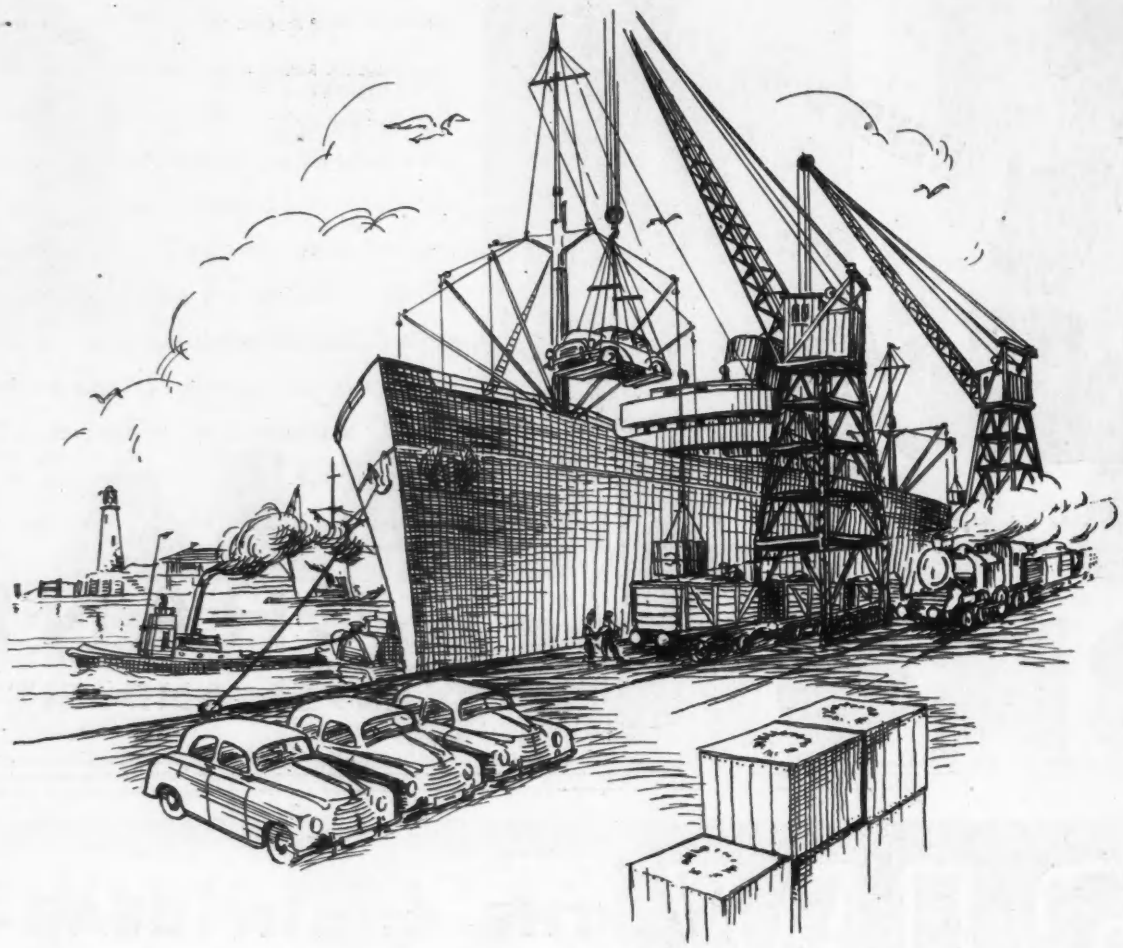

It used to be said that no matter where you went or how far you wandered from the beaten track you could be sure of finding three things—a Bible, a Scotsman and a screw made in Birmingham. In this modern age of machinery we can add a fourth, a Glacier Plain Bearing. Most machines need bearings so that their parts may move freely and quietly and without wearing out, and Glacier Plain Bearings serve this need in vehicles, ships, aircraft, power stations, pumping plant, and engineering equipment of all types. In fact wherever you find a wheel or a shaft there is likely to be a Glacier Bearing.

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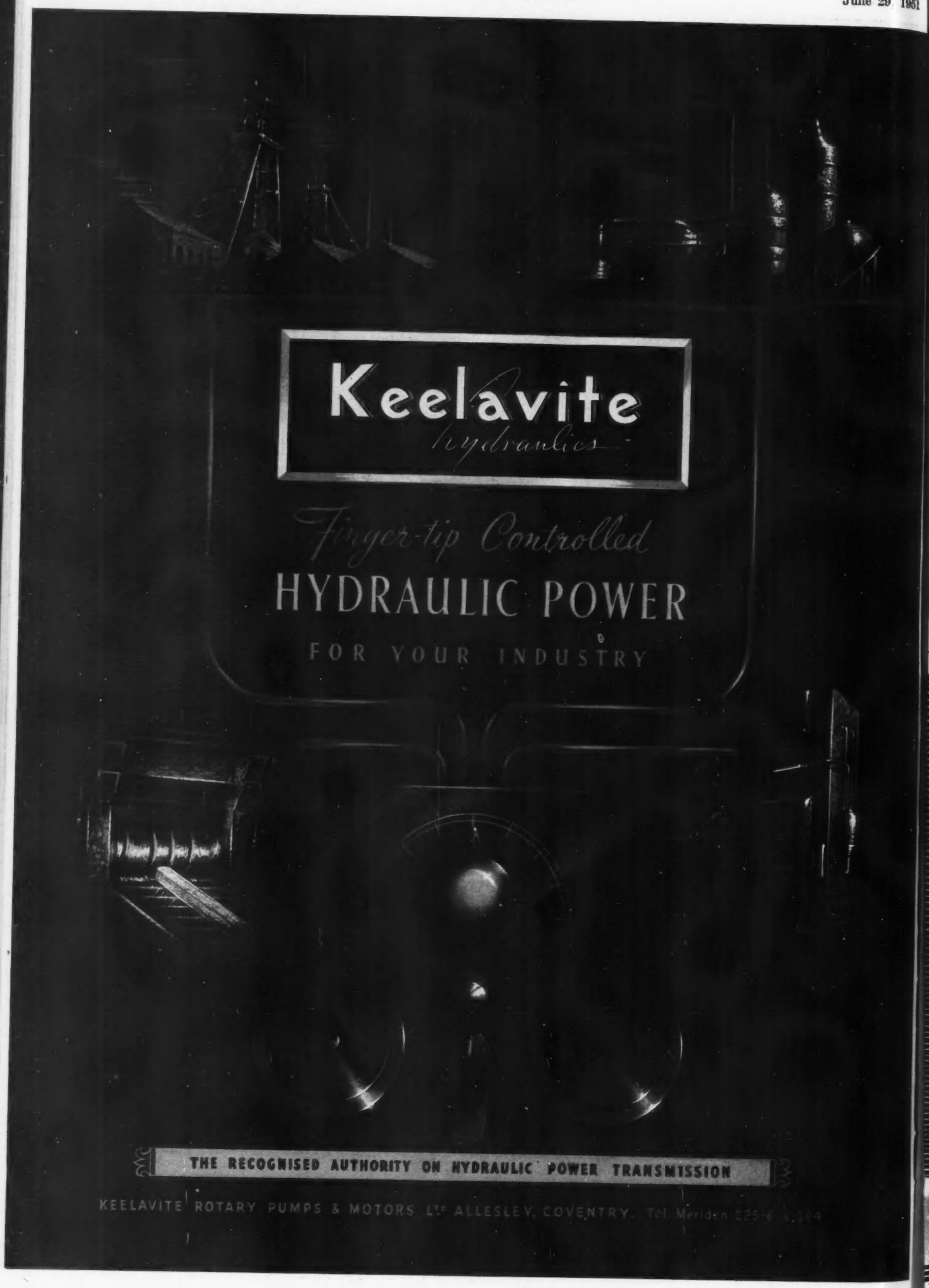
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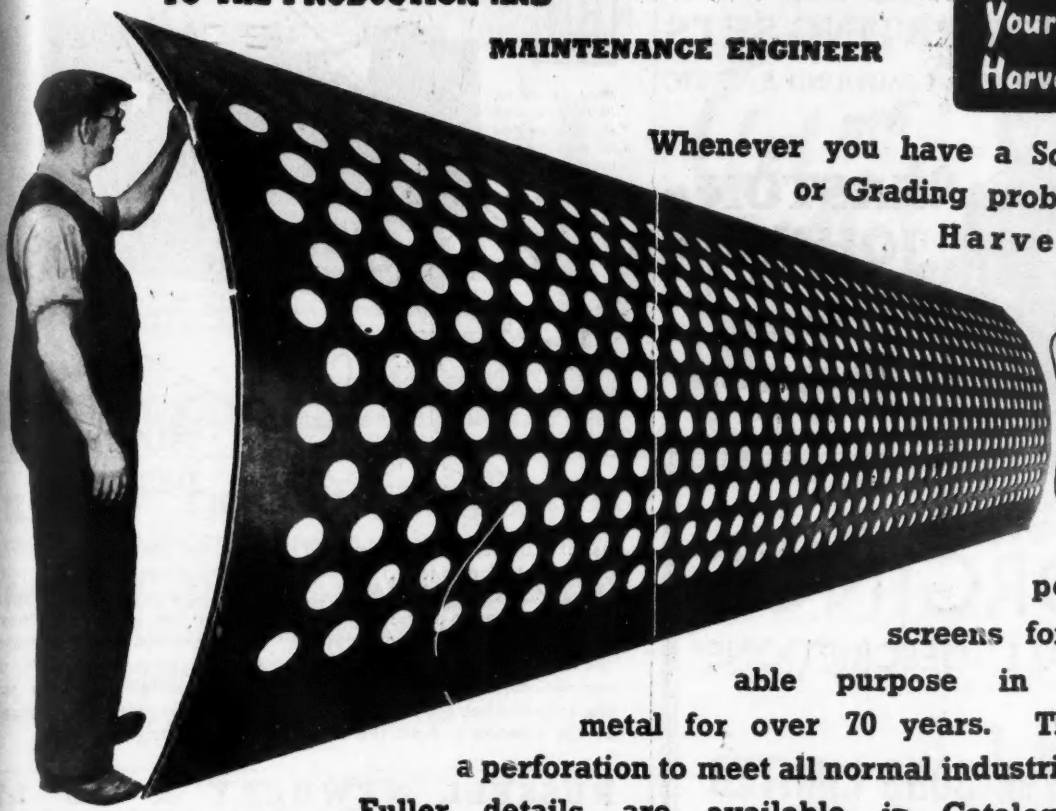

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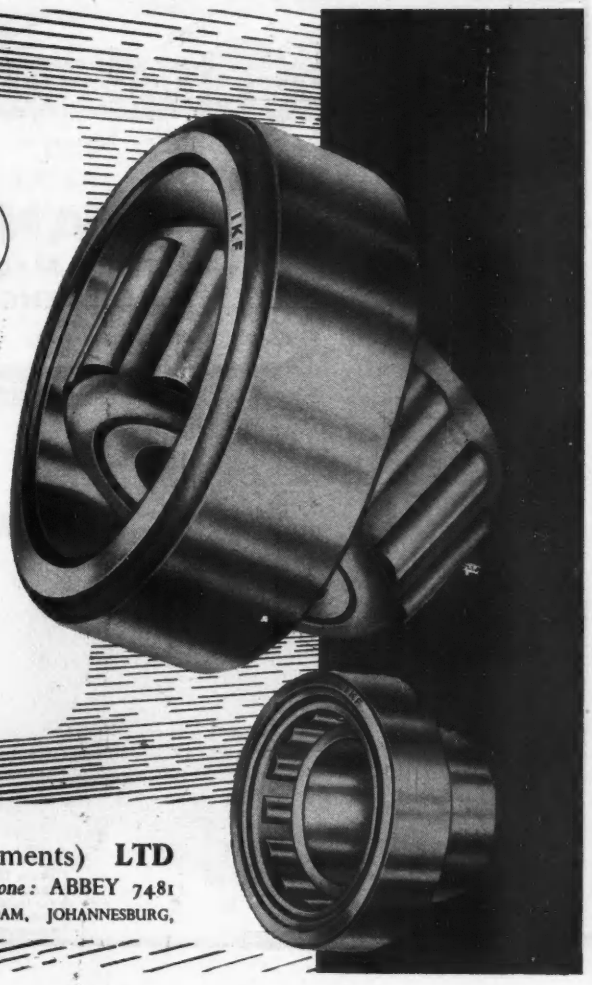

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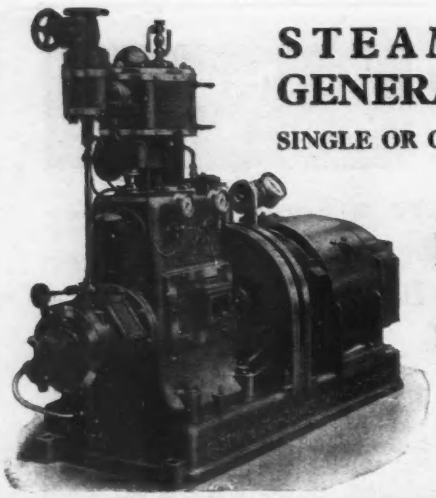

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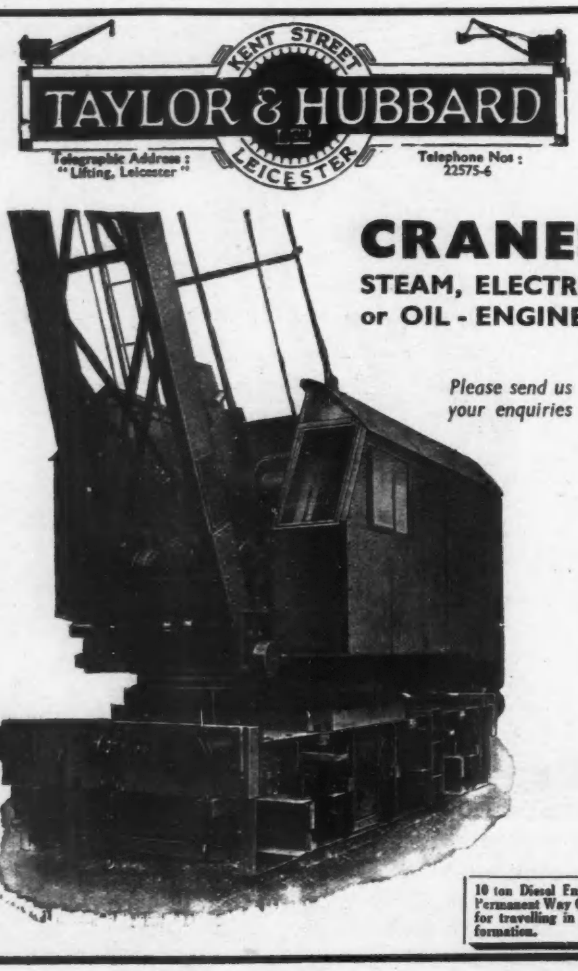

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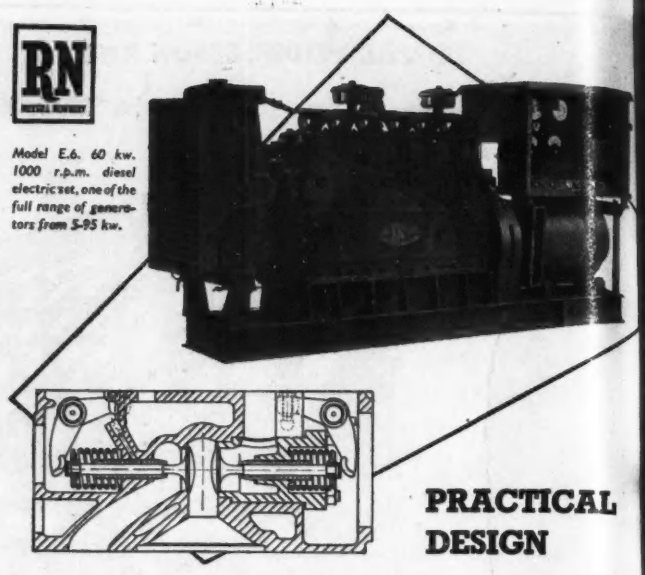

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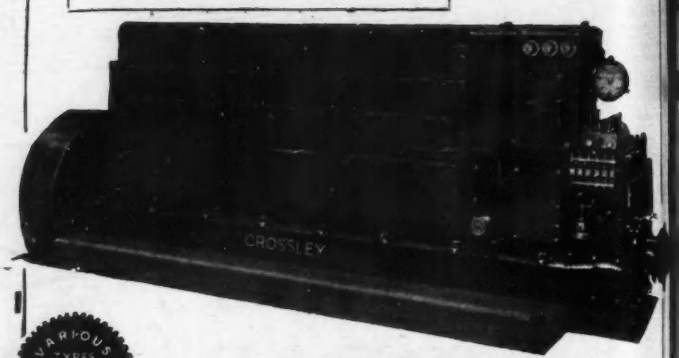

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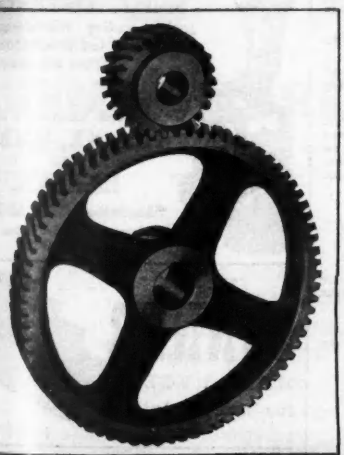

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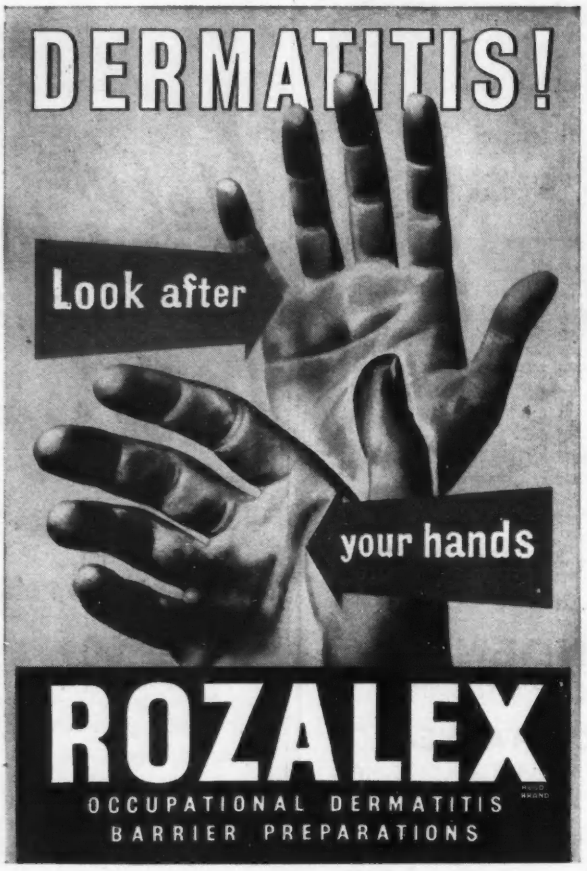

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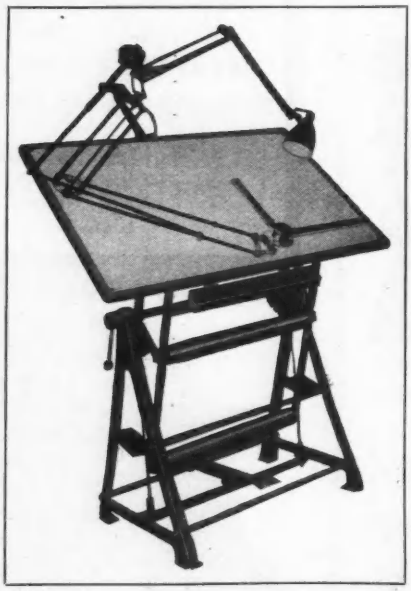

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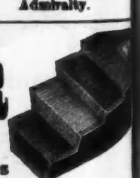

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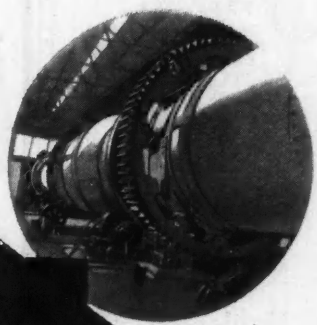

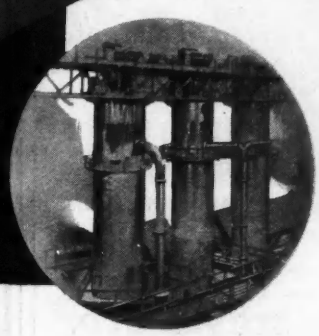

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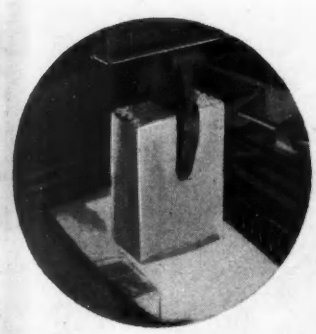

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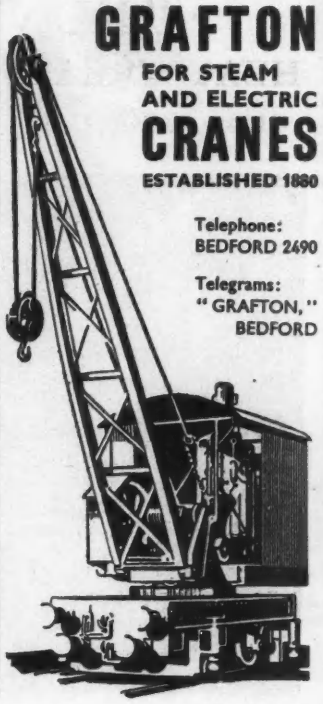

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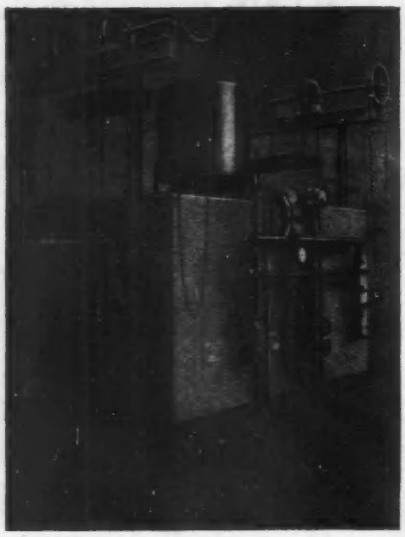

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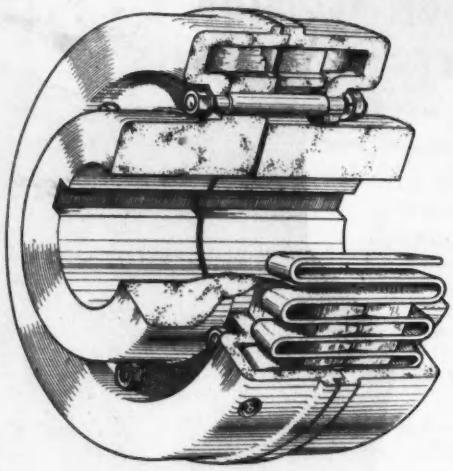

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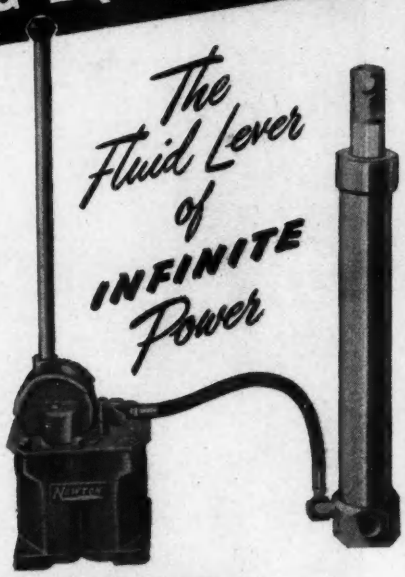

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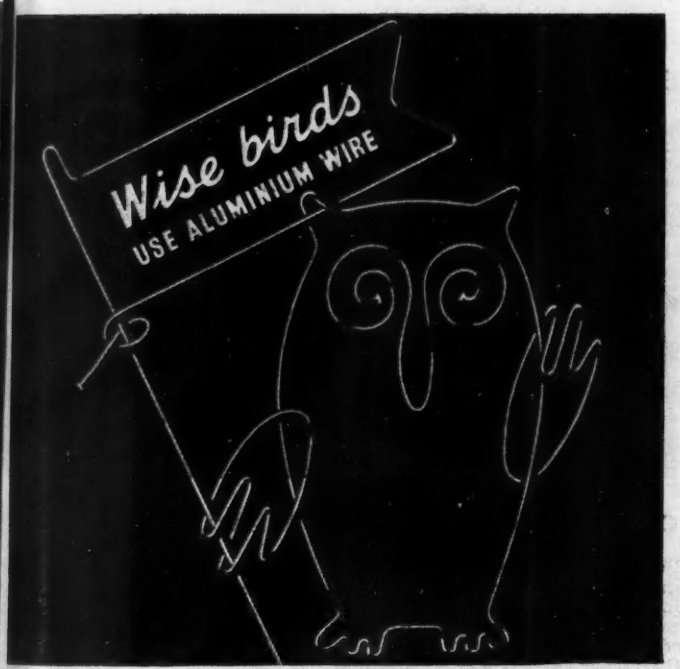

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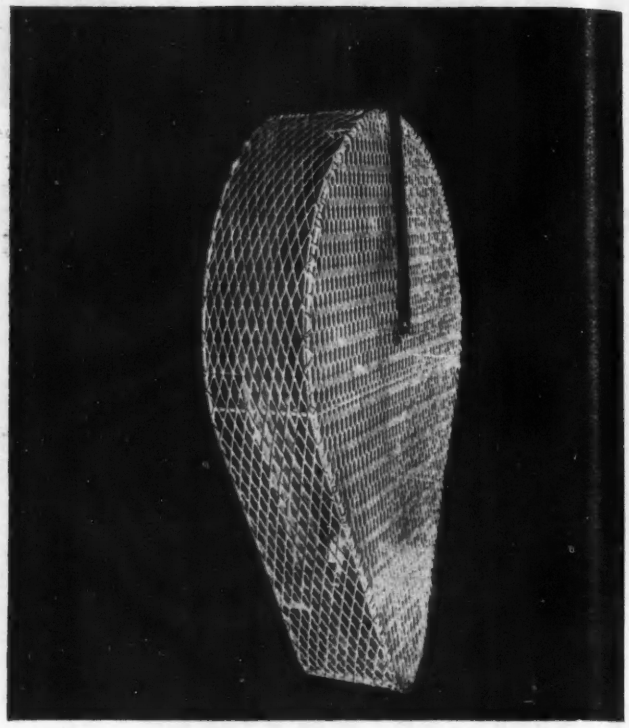

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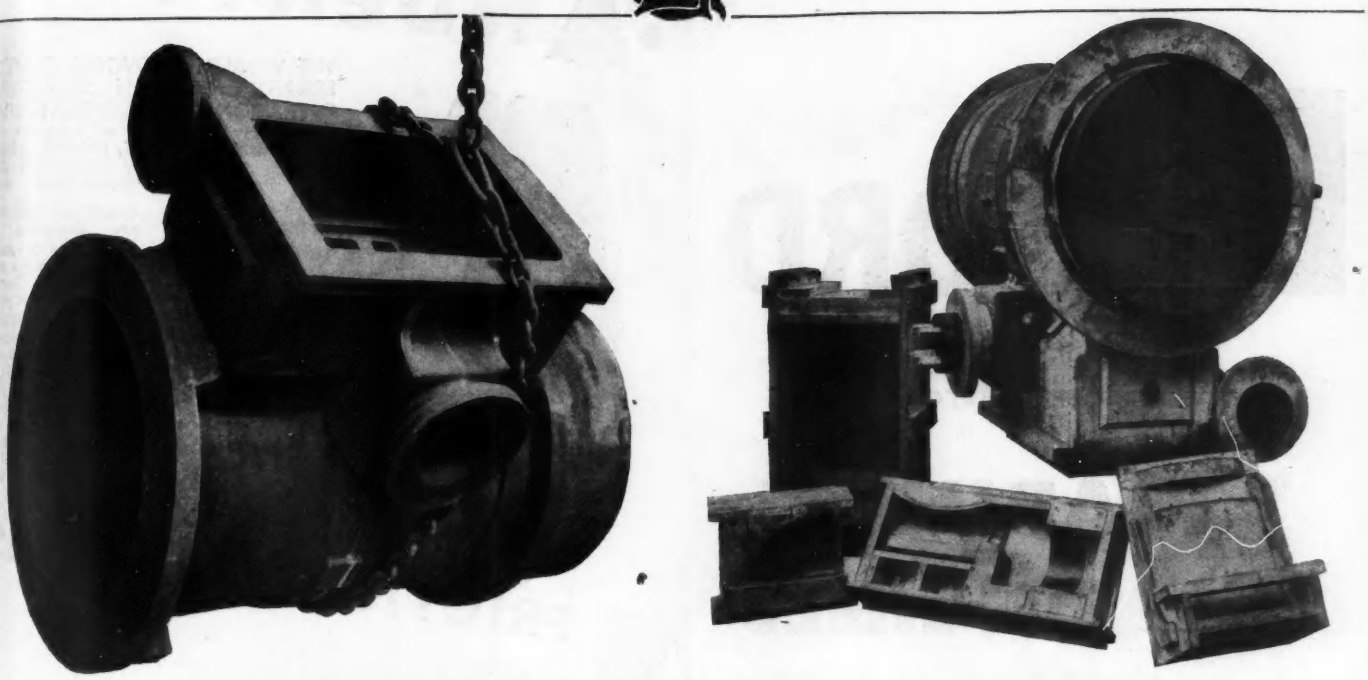

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FOR SALE

B. C. S.

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(1) 18,750kW Turbo-Alternator Set, by Fraser Chalmers/G.E.C., new 1929, single-stage steam turbine, new 1929, steam pressure 320 p.s.i., temp. 700 deg. F., speed 1500 r.p.m., direct coupled to 18,750kW, G.E.C., alternator 11,000/3/50, 1500 r.p.m., with direct-coupled exciter and auxiliary 220V D.C. generator, complete with surface condenser, air ejectors, extraction pump, circulating water pump, oil pump, tank and twin oil coolers, air filter, Lea recorder, valves, gauges, piping, &c., steam consumption 11.5 lb. per kW-hour.

(2) 5000kW B.T.H. Turbo-Alternator Set, new 1922, 350 lb. working pressure, 750 deg. F. temp., 3000 r.p.m., direct coupled to 5000kW B.T.H. alternator, 11,000 volts, three-phase, 50 cycles, 3000 r.p.m., complete with surface condenser, electrically driven water circulating pump, condensate extraction pump, oil pump, oil tank and cooler, all necessary valves, gauges, piping and spares.

(3) 1875kW Brush Ljungstrom Turbo-Alternator Set, new 1936, 160 lb. p.s.i. working pressure, 650 deg. F. temp., 3000 r.p.m., alternator 6600/3/50, 3000 r.p.m., complete with surface condenser, electrically driven cooling water pump and extraction pump, Delas air ejectors, all necessary valves, gauges, piping and fittings.

(4) 1500kW Brush Ljungstrom Turbo-Alternator Set, new 1925, 185 lb. working pressure, 550 deg. F. temperature, 3000 r.p.m., alternators wound for 6600 volts, three-phase, 50 cycles, complete with surface condenser, air ejectors, water circulating pump, condensate extraction pump, air cooler, oil pump and cooler, Lea recorders, valves, gauges, piping, &c.; in first-class condition.

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300 c.f.m. TILGHMAN, type FC6DY, vert., two stage, single crank, water cooled, 100 lb. W.P., speed 360 r.p.m., fitted intercooler and floor-mounting aftercooler, belt driven.

300 c.f.m. ALLEY and MacLELLAN, type 23B, vert., single crank, two stage, water cooled, fitted intercooler and unloader, 100 lb. W.P., direct-coupled Crompton 75 h.p. S/R motor, 415/3/50, 360 r.p.m.

300 c.f.m. BROWETT LINDLEY, makers' No. 279,299, vert., two crank, two stage, water cooled, 100 lb. W.P., "V" belt driven from 75 h.p. E.E.C. S/R motor, 400/440/3/50, 1460 r.p.m.

250 c.f.m. ALLEY and MacLELLAN, Sentinel series 28A, vert., single cyl., water cooled, 100 lb. W.P., 360 r.p.m., belt driven from 50 h.p. L.D.M. S/R motor, 440/3/50, 1460 r.p.m.

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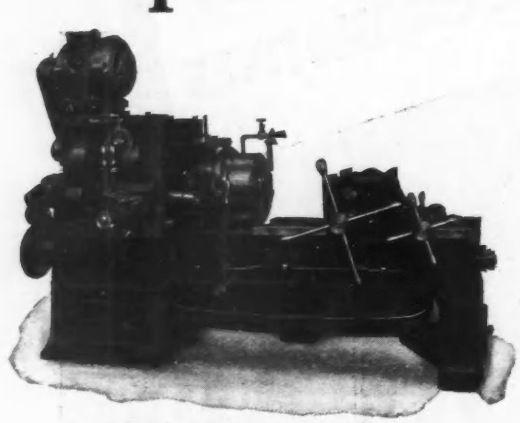

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Five Herbert 15in., 4-spindle sensitive PILLAR DRILLS, motorised 400/3/50, flat belt drive to spindles, cone pulleys giving 6 speeds 230–2050 r.p.m., No. 2 M.T., working space rise and fall table 39in. by 15in.

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B. C. S.
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1200kW complete Diesel Generating Plant, comprised of two 1250 B.H.P. vertical, six-cylinder, solid-injection, two-cycle, single-acting, super-scavenge diesel engines, by Sulzer, 375 r.p.m. each direct coupled to 600kW Met.-Vick. 220V D.C., three-wire compound wound generator, complete with switchgear, air starting equipment, exhaust systems, water-cooling tower and softening plant, fuel storage tanks, instruments valves, gauges, piping, tools and spares; installed by Sulzer Bros. in 1948.

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For continuation of Small Advts, page 108

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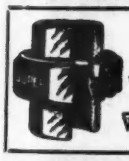

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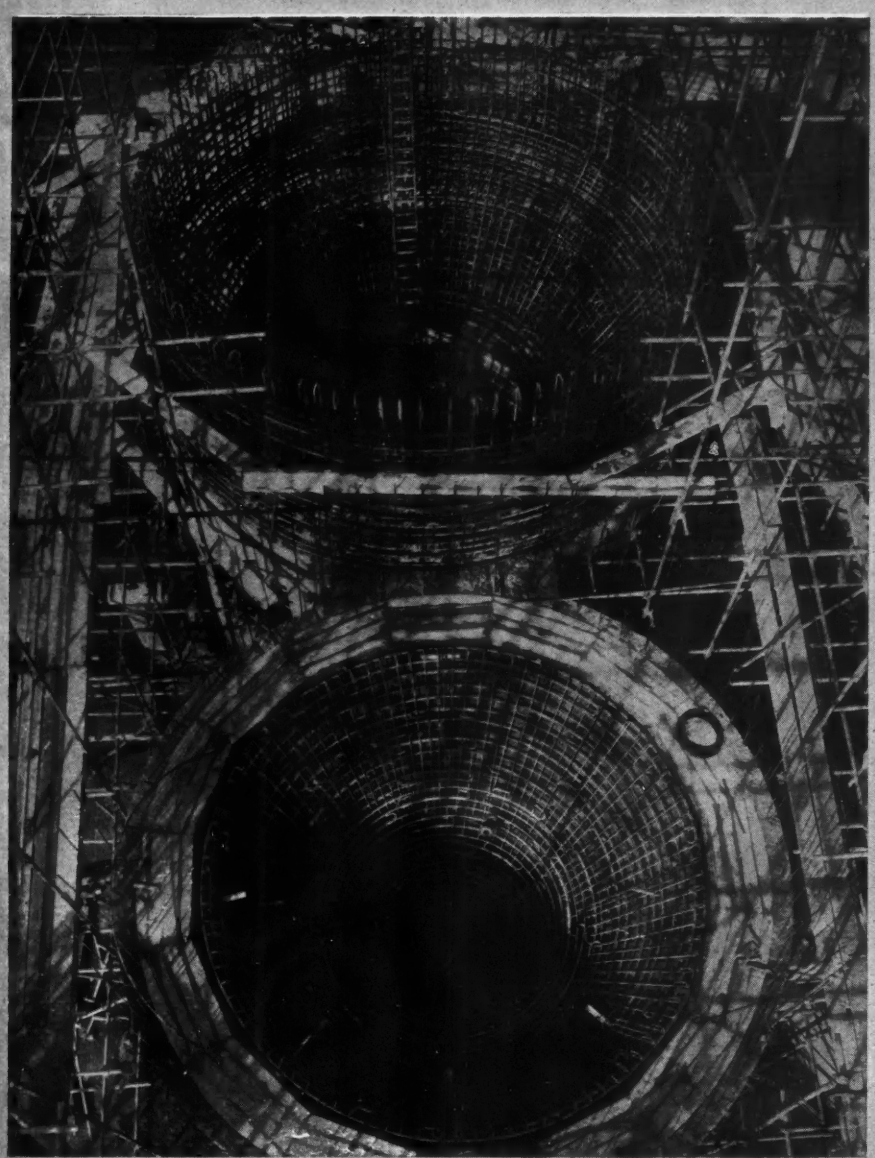

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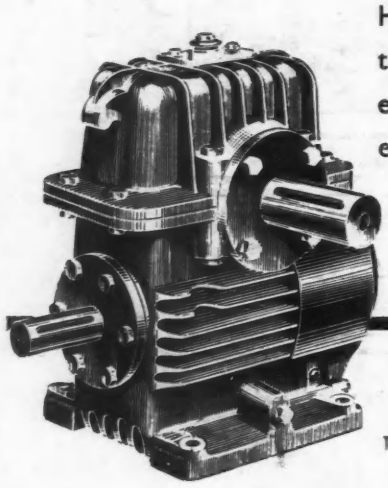

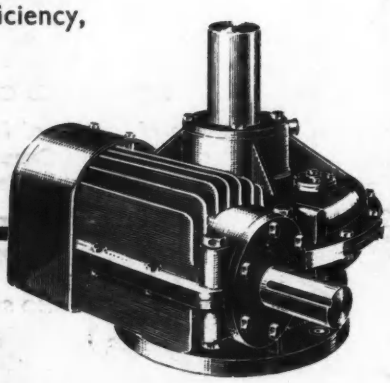

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